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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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VOL. CVIII.—No. 2800.] *LONDON: FRIDAY, AUGUST 29, 1919.* [*Registered at the General Post Office as a Newspaper.*] PRICE...9d. BY INLAND POST ... 11d.

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All applications for entry must be in the hands of the SECRETARY not later than Monday, September 1st. A 50

The University of Sheffield.

SESSION 1919-20.

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Bradford Technical College.

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Department of ELECTRICAL ENGINEERING.
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Particulars may be obtained and the drawings, etc., inspected at the County Hall before the fee is paid.
No tender received at the County Hall after four p.m. on Monday, 6th October, 1919, will be considered. A 4

JAMES BIRD,
Clerk of the London County Council.

METROPOLITAN WATER BOARD.

DISPOSAL OF CORNISH "BULL" ENGINES.

The Metropolitan Water Board invite

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TWO CORNISH "BULL" ENGINES at the Nunhead Works of the Board at Linden Grove, Nunhead, S.E.
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A schedule containing particulars of the machinery, together with the Tender Form and Conditions of Contract, may be obtained from the Chief Engineer on or after 26th August, 1919, by personal application or on receipt of a stamped addressed envelope.
Tenders, which must be on the official form, addressed to THE CLERK, Metropolitan Water Board, South Place, Finsbury Pavement, E.C., endorsed "Cornish Engines," must be delivered at the offices of the Board not later than four p.m. on the 15th day of September, 1919.
The Board do not bind themselves to accept the highest or any tender.

A. B. PILLING,
Clerk of the Board.

Offices of the Board,
South Place,
Finsbury Pavement, E.C.
20th August, 1919. A 26

COUNTY BOROUGH OF SOUTHEND-ON-SEA.

TRAMWAY RAILS.

Tenders are Invited for the

SUPPLY of approximately 150 tons Sandberg Silicon Steel TRAMWAY RAILS (British Standard No. 5).
General Conditions of Contract, Specification and Form of Tender may be obtained on application to Mr. R. H. Dyer, Borough Engineer, Municipal Buildings, Southend-on-Sea, on and after Monday, September 1st, 1919.
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The Corporation do not bind themselves to accept the lowest or any Tender.

H. J. WORWOOD,
Municipal Buildings, Town Clerk.
Southend-on-Sea. A 71

G. R.

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Note.—For *Surplus*, the detailed list of Surplus Government Property, apply at the nearest Bookstall or to a local Newsagent (to whom a standing order should be given), compiled by the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W.1. Price 3d. A 80

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2000 ft. 37/12 Bare Copper Strand, 270 ft. V.I.R. Piping.
640 ft. 4 in., 200 ft. 1½ in., 120 ft. 1 in., 60 ft. ¾ in., 85 ft. ½ in.
225 yards Tram Lines 24 in. gauge, Fish Plates, Points and Crossings, &c.
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Note.—For *Surplus*, the detailed list of surplus Government Property for sale, apply at the nearest bookstall or to a local newsagent (to whom a standing order should be given). Compiled by the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W. 1. Price 3d. A 53

G. R.

SALVAGE VESSELS FOR SALE.

The Admiralty has For Sale

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Length 125 ft.
Beam 23 ft. 6 in.
Displacement 300 tons approx.
Speed about 8 knots.
Engines: One set of triple expansion vertical engines, 350 HP., surface condensing.
Boiler: One return tube cylindrical marine boiler.

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Engines: Compound two cylinder, 21 in. and 34 in. by 23 in.
46 NHP., 225 IHP

The vessels are fully equipped with suitable plant for undertaking salvage operations.
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Tenders will be received up to twelve o'clock noon on 22nd September, 1919, for "WRANGLER," and 6th October, 1919, for "BILBROUGH." A 9

G. R.

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BY DIRECTION OF THE DISPOSAL BOARD.

For Sale, By Public Tender,

ENGINEER'S CONTRACTORS' PLANT, consisting of the following:—
One Crossley Gas Engine, 15/20 B.HP., 15 in. stroke by 9 in. diam. No. 32899.
One 5 HP. Protected Type Shunt Wound Motor, 2000 r.p.m., 230 v.d.c., with flexible coupling.
One Nitric Acid. Still in three sections, approx. 6 ft. by 6 in. diam. by 9 ft. 6 in. deep.
Two Nitric Acid Still Bottoms, 6 ft. 6 in. diam.; One ditto Upper Section.
Two Egg-ended Tanks, 17 ft. long by ft. and 3 ft. 6 in. diam.
Four C.I. Acid Eggs.
Six Jubilee Skips and Bogies, 2 ft. gaug , average ¾ cubic yard.
One Homes Patent Grab, 44 cubic ft., 5 ft. broad, with Chain and Gearing complete. Circular Pitch Pine Vats, 5 ft. ½ in. by 4 ft. 9½ in. Above lying at H.M. Factory, Craigleith, Edinburgh

LOCOMOTIVES.

Locomotive, 4 ft. 8½ in. gauge, by Manning, Wardle & Co., Saddle Tank 120 lb. per sq. in., stroke 18 in. by 12 in. diam., approx. weight empty 16½ tons. Ref. M.K. 996. Lying at Royal Arsenal, Woolwich.
Oil Locomotives, by R. Hornsby & Sons, gauge 1 ft. 6 in., stroke 10 in. by 9 in. and 15 in. by 11 in., weight approx. 8 tons. Lying at Royal Ordnance Factory, Woolwich.

SACK CLEANING MACHINE.

Box 4 ft. by 3 ft. 3 in. by 5 ft. high, with Eight leather beaters on drums fitted on 1½ in diam. shaft. Secondary shaft having a rotary brush. Complete with movable grid for feeding sacks into machine, and six dust shoots. Lying at Main Supply Depôt, Glasgow. Ref. M.K. 9972.

10 TON LOCO. CRANE.

10 ton Loco. Crane, by Whittaker. Ref. M.K. 9972 Lying at A.C.S. Depôt, R.A.F., West Drayton.

ACETYLENE WELDING PLANT.

Six Acetylene Welding Plant, complete with generator and mountings, 15 in. diameter by 2 ft. 9 in. high, carbide container, Watchman type, 18 in. dia.
One Acetylene Welding Plant, Imperial type, with burners, &c. Lying at Portobello Aerodrome, Edinburgh.

ELECTRIC WINDING PLANT.

100 HP. Motor, 440 v. three-phase variable speed. Controller by Siemens. Oil immersed reverse current controller. Single 8 ft. drum with extended bed for motor, couplings, balance weights, 250 yards 1 in. wire rope, water lifting buckets, timber, &c. Lying at Government Cartridge Factory No. 1, Blackheath Depôt No. 92, Birmingham.

GRAVEL WASHING MACHINE.

Gravel Washing Machine with graduators to pass, approx. output 75/100 yards per day. Belt-driven. Ref. M.K. 8058. Lying at Grain Island Firing Point, Isle of Grain, Yartlett Creek, Kent.

MORTAR PANS.

Three Mortar Pans. Ref. M.K. 8073.5.6. One Concrete Mixer and Engine combined. Ref. M.K. 8076. Lying at Henlow Repair Depôt, via Shefford, Beds. Ten Field Forges, 2 ft. dia. by 2 ft. 6 in. high, with bellows. Lying at Portobello Aerodrome, Edinburgh.

BEACON LIGHT PETROL AIR GAS GENERATOR by the British Motor Co., Ltd., suitable for 120 lights with generator; Gasometer, Feed Tank, Tower with pulleys, cable, etc. Ref. M.K. 7849. Lying at Strensall Camp, Yorkshire.

PLATE BENDING ROLLS for masts, capable of bending up to 12 ft. wide by ¾ in. dia. arranged for electric drive, driving by 40 HP. motor and 25 HP. motor for lifting top roll. Speed of motors 500 r.p.m., top roll so arranged that plate can be removed after being bent to a circle, no motors included. Overall dimensions 22 ft. 6 in. by 6 ft., without motors.
Lying at Works of Messrs. Berry & Co., Ltd., Croydon. Works: Leeds. Ref. M.K. 8838.
Tenders for above must be received not later than Ten a.m. on October 2nd. Tender Forms and Permits to view can be obtained on application to the CONTROLLER, D.B.1. (H), Charing Cross Embankment Buildings, London, W.C. 2.

Note.—For *Surplus*, the detailed list of surplus Government Property for sale, apply to the nearest bookstall or to a local newsagent (to whom a standing order should be given). Compiled by the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W. 1. Price 3d. A 66

THE WORKS AND PRODUCTS OF MESSRS. BARR AND STROUD, LIMITED.

(*Continued from page* 200.)

TURNING now to details of the machine shops it will be seen from an inspection of the plan, Fig. 1, on page 198, *ante*, that the whole of the departments dealing with machining are placed together in the area immediately to the west of the foundry and pattern shop. The specialised nature of much of the work carried out has made it possible to concentrate the automatics and the gear-cutting machines in special shops, but these, as will be seen, are immediately contiguous to the main general machine shop. The machinery in the main shop is as far as possible segregated into groups, and part of the shop serves as a tool-room. The tool-room plant is situated in the two easternmost bays. Two views inside the machine shop are shown in Figs. 12 and 13, on Plate XIV. As will be seen from these views the shop has a completely glazed roof and is artificially lighted by independent metallic filament lamps over the individual machines. The main shafting is carried down the centres of the bays, being supported by hangers carried from the roof principals. The driving motors are fixed overhead, as is shown in Fig. 12. Countershafting is mostly carried from stringers on the roof principals.

FIG. 11. THE AUTOMATIC SHOP.

As we have already said, the machines are as far as possible segregated into groups of similar type. In view of the class of work produced much of the machinery naturally consists of capstan lathes and milling machines, suitable for dealing with small and medium-sized work. There are, however, some fairly heavy machines in the west bay. There are, for instance, five Pearns' borers. These are used for boring the prism holders for the largest rangefinders and for dealing with naval mountings. It should perhaps be said here that, although we have referred to the work turned out as, on the whole, of a small type, the modern naval and fortress rangefinders are, none the less, bulky and heavy instruments. The largest rangefinder built has a 35-ft. base, and it will be realised that the casing carrying the optical parts, and the stand on which such an instrument is mounted, are of necessity fairly heavy objects. The erecting of the heaviest instruments and mountings is carried out in the north-west works, where also the heaviest machinery is situated; to this we will refer later, but many of the parts are dealt with in the shop with which we are now concerned. This bay also contains two Cincinnati radial drills, a number of Brown and Sharpe and Churchill grinding machines and Jones and Lamson and Warner and Swasey turret lathes.

The next bay is largely made up with heavy Brown and Sharp turrets, Pittler semi-automatics and Brown and Sharpe milling machines. The next bay eastward contains a number of radial and other drilling machines, slotting machines, vertical and horizontal millers, grinders and a number of smaller turret lathes. Part of this bay, together with part of the next, constitutes the tool-room. This has an equipment of about 40 machines, consisting of precision lathes, shapers, millers and other such usual equipment. The tool-room manufactures a large number of jigs and other shop fitments as well as tools proper. Immediately alongside the tool-room, at the south end, there is a heat-treatment shop containing five gas furnaces, with an equipment of bosches, quenching tanks, &c. This shop also contains two drop-stamps, the larger having a 5-cwt. tupp. These hammers are available for any miscellaneous work which may require to be done, but in addition are regularly employed in drop-forging rangefinder parts. It is the practice to treat numbers of small cast brass parts under the hammer by heating them to a dull red and forging in dies. This results in parts of a more uniform size and better finish and also improves the quality of the material. This shop also contains a pair of sheet metal rolls and other miscellaneous machinery. Immediately alongside the heat-treatment shop there is a small forge for dealing with tool-room and other work.

The north end of the eastern bay of the machine shops form what is known as the tube shop. It is here that the tubular members which form the main body of the rangefinders are machined and built up. We will deal with the construction of the instruments more in detail later, but in connection with the equipment of this shop may say here that the rangefinder bodies are built up of brass or copper tubes machined on the ends and forced on to a central brass or gun-metal portion, so that the whole forms a continuous tube. Such built-up rangefinder bodies can be seen in Fig. 16, on page 265, which shows part of the north-west works. The equipment of this tube shop consists in the main of lathes by Lang, on which the turning of the tubes is carried out. There are also some horizontal hydraulic presses by which the machined tubes are forced on to the centre casting. These machines are built on the lines of a long lathe with a headstock to hold the centre casting and a horizontal ram to press the tubes into place. The machines are self-contained, with three-throw belt-driven pumps feeding the hydraulic circuit. This tube shop also contains some Taylor and Challen and other presses, and two guillotines. This machinery is used in connection with the manufacture of the inner frames of some classes of rangefinder. These inner frames carry the central optical parts.

The automatic shop and gear-cutting shop, which are alongside the tube shop, we have already mentioned. Their purpose will be obvious. The automatic shop, which is shown in Fig. 11 annexed, is equipped with 16 Brown and Sharpe full automatics, and turns out the small screws and similar parts which are required in large numbers for the rangefinders and other instruments which are manufactured. The gear-cutting shop similarly produces the various gears which, to a greater or less extent, form an important part of all the instruments. This shop is illustrated in Fig. 15 on Plate XIV. It contains six bench lathes, some Brown and Sharpe screw machines and horizontal millers, four Pratt and Whitney tool-room lathes, two Reinecker gear cutters, two Gleason, two Farwell and one Fellowes. There are also two rack-and-pinion cutting machines by Köpfer and Sohne. The chairs in front of the bench lathes, which can be seen in Fig. 15, are for the use of the wounded soldiers who operate these machines. It is not necessary to enter into the machining methods employed in these various machine shops, as they do not differ from those current in other good works turning out the same class of material. As there is much repetition work and a very high standard of accuracy is necessary, a very complete jig and gauge system is in use. We referred in our first article to the inspection department, and its independence from the manufacturing side of the works.

The fitting shops we need not say much about. They are supplied with vice benches, some sensitive drills, gas-heated soldering irons and other similar small plant. We should refer, however, to the engraving department and paint shop, which are situated near the north-west corner of the works. In the former of these the large number of scales, and name and instruction plates which are required are made. There are a considerable number of Taylor, Taylor and Hobson engraving machines, and, in addition, a number of special machines for marking scales. In these the scale which is being engraved and the scale from which it is being copied are mounted each on a common pivoted frame. The scale which is being copied is viewed by the operator through a telescope with cross wires, so that the frame can be set accurately for each division. When it has been so set for any one division an engraving tool, carried by a parallel motion gear, is moved over the scale which is being cut, and so reproduces the division at which the machine is set. This process is repeated for each division until the whole scale has been engraved. In connection with these machines it should be said that there are no standard scales for rangefinders. Each scale is determined experimentally for each instrument, and is then reproduced in permanent form by the machines with which we are dealing.

In addition to this engraving machine shop there is a photo-etching section in connection with the engraving department. This contains plant for making brass labels and instruction plates by photographing on to the previously sensitised plate and etching with acid. The plates are afterwards finished by polishing and filling in with coloured wax. Between the engraving department and the paint shop there is an electro-plating department, which contains various electro-plating vats, washing tanks, &c. There is also a large coslettising tank. The paint shop contains drying ovens and an exhaust duct arrangement, by means of which fumes are carried away and discharged outside. The paint used has a celluloid base and dries to a very hard surface. It is put on with an air spray working at about 80 lbs. pressure, and very smooth and regular work results. In general two colours only are used—khaki for military instruments and slate-blue for naval.

After assembling, all rangefinders are taken to

special departments for calibrating and adjusting. These are situated on the second floor of the three-storey building which forms part of the factory. A plan of this second floor is given in Fig. 3 of our previous article, while the position of this three-storey erection in reference to the other parts of the shop is well shown in Figs. 5 and 6 on page 199 *ante*. There are separate departments for dealing with small and large instruments. These shops are supplied with collimators for calibration and adjustment of the rangefinders. They are also provided with sliding windows, through which direct tests of the instruments can be made on posts set up in the surrounding country at known distances from the works. The flat roof of the shop is also available for this class of testing. Each of the adjusting shops contains a closed chamber, which can be artificially heated. Tests of the accuracy of the rangefinders at different temperatures are carried out in these chambers. The range of temperature over which an instrument may be operated in practice is, of course, very great. The same range-finder may well be used in the north of Europe in the winter and at the Equator. The actual testing and calibrating of the instruments we will refer to later when dealing with the details of their construction.

Before proceeding to deal with the optical departments we should refer to the north-west works, which forms a section of the machine and erection departments. Two views in this works are given in Figs. 16 and 17 on page 265. This works consists of a rectangular building measuring 180 ft. by 133 ft. and with an annex containing an ambulance room and lavatories. The building is of a simple type, as will be clear from the views referred to. The roof, as there shown, is half glazed. The shop contains a number of heavy machine tools for dealing with the main parts and mountings of the larger class of rangefinders. Fig. 17 shows the main tube of a 30 ft. base rangefinder in the lathe. Such tubes, as we have already said, are built up of independent tubes machined at the ends and forced on to a central casting. Various bearing parts on the outer surface of the tubes have also to be machined. It will be very clear from Fig. 17 that although a 30 ft. base rangefinder is certainly an instrument, none the less it approaches in size the dignity of an engineering structure. As shown in this figure, overhead runways are fitted in the shop for handling these heavy parts. Fig. 16, the other view in the north-west works, shows a pair of heavy rangefinders being fitted to their mountings. The articles which can be seen on trestles behind these mountings are periscopes for submarines, a number of which were manufactured by Messrs. Barr & Stroud during the war.

Other mechanical departments which should be mentioned before we leave this part of our subject are the electrical instrument shops, the plant repair shop and the experimental shop. In the first of these the various electrical instruments which are manufactured by the firm are made and assembled, and non-machine operations, such as coil-winding, are carried out. The main apparatus passing through these shops formerly consisted of fire-control gear and its accessories, but the construction of water-tight door indicators for ships now forms an important branch of work. We shall refer more in detail to this apparatus later. The plant repair department contains the usual general purpose machines which are necessary in the upkeep of a factory of this class. They need not be referred to in detail. The experimental machine shop we illustrate in Fig. 14 on Plate XIV and Fig. 18 on page 278. This shop is situated in an extension arm of the first floor of the three-story building. The general construction and lay-out of shop with its double side-lighting is well shown in the views given. The shop is equipped with a series of milling machines, precision lathes, &c. It is the practice to build any new type of instrument throughout in this department before it is introduced into the main part of the factory. In addition much experimental work and tentative instrument making is carried out. As will be evident from our illustrations, this experimental department is in itself a large and well-equipped machine shop, and it is probably not too much to say that the remarkable development in range-finders which the history of Barr & Stroud covers, would not have been possible had the firm not from the first adopted a bold policy in connection with experimental work and looked upon an efficient experimental department as part of their normal equipment.

Turning now to the optical side of the factory we should first refer to the glass shops, which can be seen to the north of the machine shop in the plan, Fig. 1 on page 198 *ante*. These shops are devoted to the actual manufacture of the glass from which the lenses and prisms used by the firm are made. The manufacture of glass was started by the firm only during the war and the capacity of the plant as yet is insufficient to meet all their requirements, but the material is now manufactured in large quantities. In connection with this aspect of Messrs. Barr & Stroud's activities we should say that as a rangefinder must be capable of measuring an angle of half a second (which is equivalent to distinguishing between 400,000 and 400,001) it is imperative that the optical properties of the glass employed should be of a very high order. Before the war practically all the glass used in Messrs. Barr & Stroud's instruments was obtained from Messrs. Chance Bros., but at an early stage of hostilities the difficulty of obtaining sufficient quantities of glass with good optical properties became so great that the production of large range-finders was seriously jeopardised. This state of affairs arose, we believe, from considerations beyond the control of either of the firms concerned. The result, however, was that Messrs. Barr & Stroud were compelled to consider the manufacture of glass for themselves.

In the first instance the method of fine annealing was investigated, and in 1915 several electrical annealing chambers were in continual use, and all fine annealed glass received by the firm was subjected to this additional annealing process. During that year an experimental plant for the manufacture of glass was also established and within nine months the first successful large melt of optical crown glass was obtained. More recently the manufacture of flint and other glasses has been developed. A systematic investigation of the various types of glass has been in progress since 1917 and already results of considerable practical importance have been obtained. Many improvements have also been introduced by the firm in the design of glass furnaces and stirring plant, in the development of electrical pot arches and in the manufacture of glass melting pots. Arising from the necessity for a sufficient supply of good optical glass Messrs. Barr & Stroud have thus been able during the war to establish the complete manufacture of this essential product. We believe Messrs. Barr & Stroud were not recognised by the Ministry of Munitions as glass manufacturers, and that they had to carry out their important work without official assistance in the obtaining of suitable raw material. Prohibited materials of the trade they had to do without.

The glass shops contain a department for the manufacture and drying of pots. The main glass shop contains a gas-heated furnace for glass manufacture and electrically-heated furnaces for annealing. In the making of lenses, &c., the mass of glass which is formed in the pot is broken into pieces of suitable weight, which are then softened by heat and pressed to shape in cast-iron dies in a hand press. Rough lenses and prisms approximating closely in shape to the finished article can rapidly be made in this way. These roughly-formed articles have then to be annealed to remove internal strain, the operation taking several weeks. The glass parts, leaving the annealing furnaces, are then ready to go forward to the glass-working shops, which are situated in the West Works.

From Fig. 1, already referred to, it will be seen that the West Works contains three main shops, respectively for roughing, smoothing and finishing, and in addition hand-smoothing and hand-polishing shops, a cementing shop, together with inspection and other miscellaneous departments. The names of these various shops fairly well indicate the processes through which the glass parts are passed. The first operations take place in the roughing shop, a view of part of which is given in Fig. 19, on page 278 The work in this shop is mainly confined to prisms as moulded lenses are in general sufficiently near to finished dimensions to be passed on direct to the smoothing shop. Prisms, however, are to a considerable extent made from roughly-moulded blocks and have to go through a preliminary roughing operation.

In making a prism from a rough annealed block the first operation consists in cutting the block roughly to shape. This is done by means of a revolving iron disc which carries diamond dust on its outer edge. The disc is charged by roughening it with a file and rubbing the diamond dust on to its roughened edge. The direction of rotation of the disc is then reversed and the rough teeth formed on its edge are closed down over the diamond particles by holding some flat object against the rotating edge. A disc charged in this way will last about four days. During cutting the prisms are fed against the disc by hand, and the rate of cutting is fairly high. A cube of glass of a couple of inches square face would be cut through in a few minutes. The next process in the manufacture of the prisms is the rough grinding of the various surfaces. This, in the case of a single specimen, is done by holding it against a horizontally-revolving cast-iron disc fed with carborundum. Such a disc can be seen in the foreground near the centre of Fig. 19. When, however, a number of similar prisms are being made they are mounted on a jig which locates them by one of their faces or angles. They are secured in the jig by means of cement. Much of this work of mounting prisms and other glass parts on to jigs with cement is necessary, and a special cementing shop is set apart for the work, as shown in Fig. 1. When mounted, the prisms are all ground together in one operation. The work may be carried out on a rotating disc, as in the case of a single specimen, or a more complicated form of grinding machine may be used. At the left-hand side of Fig. 19 a battery of horizontal grinding machines which are used for this class of work may be seen. There are ordinary traversing table machine shop grinders adapted for dealing with glass by fitting special gearing to give a much lower wheel speed than is usual for grinding metal. A carborundum wheel is used. We believe the adoption of ordinary machine tools for dealing with glass in this way is unique.

The rough grinding of prisms in a jig brings them automatically to correct geometrical shape, and they are then passed on for smoothing, which is merely a repetition of the grinding process with a finer carborundum. The next process, that of polishing, is again in essence the same thing, except that rouge (Fe_2O_3) is used instead of carborundum. A rough polish is given in the first instance sufficient to enable a goniometer test to be applied, in order that errors may be corrected, if necessary, by further grinding, before the prisms go forward for final polishing. After the last polishing by machine a final touching up to bring to perfection is usually necessary in the case of the finest work. This work is carried out by hand by rubbing the prisms on a pitch face-plate, which is fed with rouge. The face-plate is divided up by a number of shallow grooves, which hold the rouge.

Hand smoothing and polishing are carried out in special shops, the position of which is shown in Fig. 1. The processes require a high order of skill, as the results produced depend entirely on the individual workman. The flatness of the surface produced is ascertained by the "Newton's Ring" test, the prism being placed on a quartz proof plate. The skill of the best polishers is remarkable, as, in addition to the difficulty of producing an absolutely flat surface, it is in some cases necessary to slightly deviate from such a surface in order to make correction for slight local variation in the quality of the glass. It will be clear that the whole of this prism-polishing process is a laborious and expensive one, and that continual testing is necessary throughout the work.

Lens grinding and polishing are carried out in the smoothing and polishing shops—shown in Fig. 1. Views in these shops are given in Figs. 20 and 21 on page 278. Grinding and smoothing is carried out with carborundum and polishing with rouge. In general the lenses are mounted on a jig with cement, in the manner we have already referred to

THE WORKS OF MESSRS. BARR AND STROUD, LTD., ANNIESLAND, GLASGOW.

(*For Description, see Page* 263.)

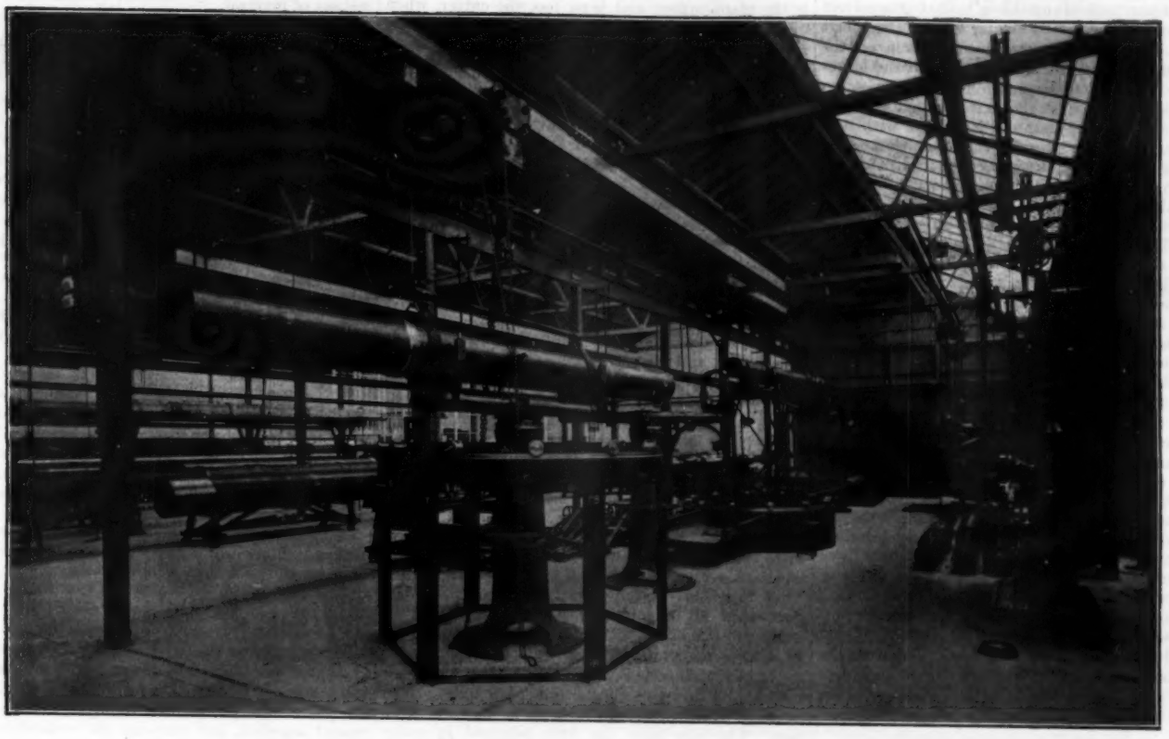


Fig. 16. Heavy Rangefinder Mounting Department; North-West Works.

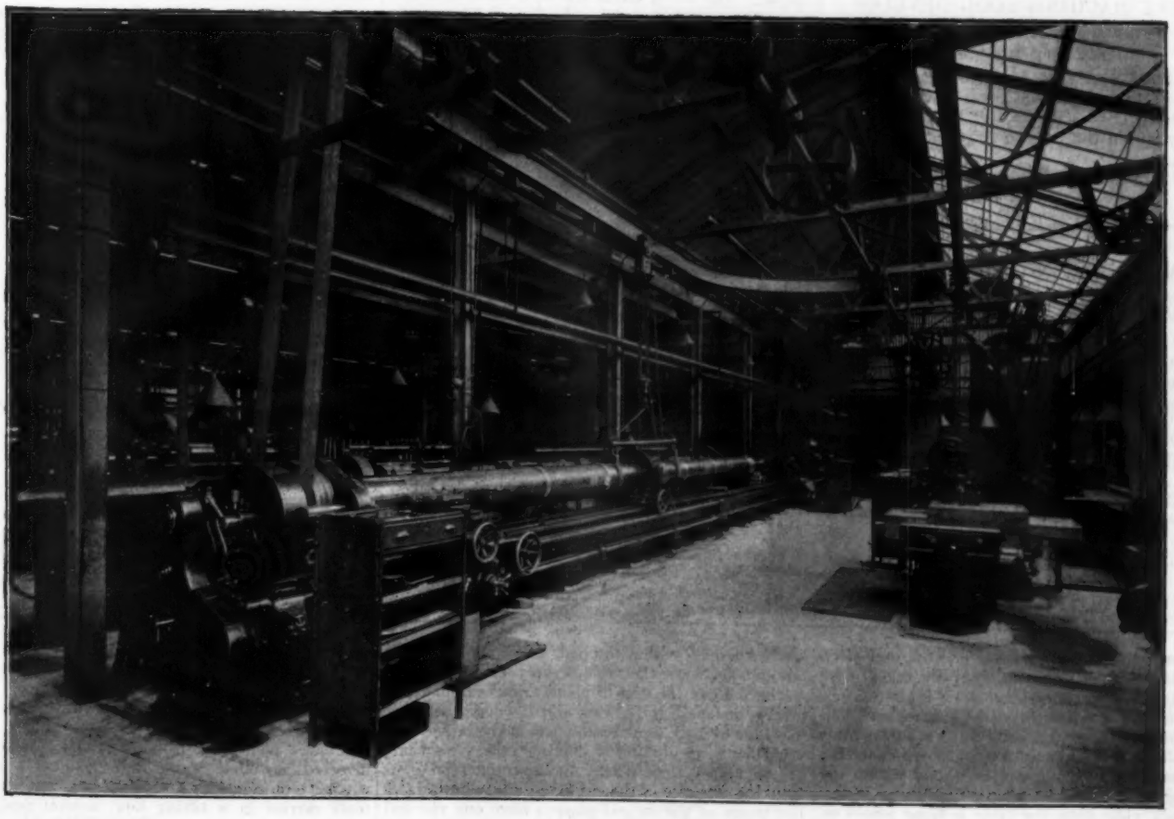


Fig. 17. Heavy Rangefinder Machine Department; North-West Works.

in connection with prisms, and are smoothed and polished in batches. They are, of course, approximately of correct form before any grinding is begun, as they are moulded in dies in the glass shop. When the lenses are mounted on their jig they are acted on by cast iron tools of cup shape, made to the correct form necessary for the particular lenses being dealt with. A batch of such tools can be seen on the centre bench in Fig. 20, while a jig with the lenses mounted for grinding or polishing can be seen on the right-hand bench at the extreme right-hand of the figure. The cup-shaped tool is fed with carborundum or rouge during the operation. The smoothing or polishing is carried out by machines which in general have a continuously-running horizontal shaft carrying friction discs, which drive friction wheels mounted on a series of vertical shafts. The vertical shafts drive grinder-holders through a link-motion and lens-holders through belts. The lens-holders and grinder-holders both rotate, but the link-motion gives the latter an eccentric movement around the vertical line through the lens-holder, so that ridging of the tool or glass is prevented. There are a number of types of these lens-polishing machines in the shops, but all produce this effect of both relative rotation and translation between the cup-shaped tool and the lenses. In some late machines of Messrs. Barr and Stroud's own construction the eccentricity of motion between the two revolving parts can be varied while the machine is running. In the case of a lens in which the curvature of the face is considerable it is not possible to mount a number together for grinding in the way we have described, and the lenses have to be treated individually, but the other features of the operation remain the same. The mounting of the prisms and lenses in the instruments and other mechanical details in reference to the optical parts will be best discussed in connection with the illustrations of some of the actual rangefinders as built by the firm, to which we will direct attention in a later article.

(To be continued.)

RECENT MACHINE TOOL DEVELOPMENTS.—No. IV.

By Joseph Horner.

Beds, Ways and Reciprocating Slides.—In this great group the conditions of stress differ from those present in the lathes in the fact that the stresses lie mostly within the bases or framings, instead of being concentrated on one shear or way, and often outside it. The cutting also generally takes place longitudinally, so that torsional stress is absent.

The Planing Machine Group.—This machine, and those derived from it and built on its model, stands almost alone in machine grouping, in the fact that the stress of cutting takes place wholly within the encircling base and framing. Exceptions occur when work wider than the table is being tooled on the edges, and in wide objects being tooled on open-side planers. But ordinarily the bed, table and housings lie entirely and considerably outside the cut. The weak element here is that of the mounting of the tool in a box that projects down, cantilever-like, from the cross rail. Of similar design to the planer is the plano-miller, and here, too, the cutter, when of large diameter, is a disturbing element. But if these machines are compared with some others having reciprocating tables, or tools, or rotating tools, their advantage is marked. A side-planer, a shaper, or a lathe when working on large diameters, suffer from the effect of overhang in some essential elements, which tends to cause deflection and spring under heavy cutting. Again, in drilling machines, and the pillar and knee milling machines, the vibration consequent on the projection of the tools is counteracted by the provision of extraneous supports, as in the adjustable slides for the lower ends of drilling spindles, the tool stays for the spindles of vertical milling machines, and the numerous braces attached to horizontal milling machines. From these ills the ordinary planer is free, and the slides that lie well outside and flank the cut are slides pure and simple, requiring no provision to prevent lateral tipping, or lifting in the longitudinal direction providing the bed and table are constructed with sufficient rigidity to resist flexure, as they are in most designs. This aspect of the wide subject of machine framings is one which teems with details of much variety and value.

Fig. 47 shows a Cunliffe and Croom planer bed and table in end view, with its sections dotted. Of the ordinary vee slide-way design, it is provided with very special means for collecting the waste lubricant, Figs. 48 and 49. The uprights or "housings" are bolted directly down on the wings that stand out on each side of the main bed, which seems preferable to abutting them and locating them with keys on vertical faces. On the other hand many heavy planers have the housings on the sides, but carried down to the bottom of the bed. The cross-girts are of boxed section, as in all designs now. The legs have the form adopted in many heavy lathes, with a large bearing face on the bed, and a narrower face on the floor, and they are well spread. The vee'd slides are of a medium angle, being 100 deg. included by the faces. The special provision made to collect the waste lubricant from the vee slides, consists of a passage, Figs. 48 and 49, that connects the two vees, and discharges into a shallow trough within the bed, which can be drawn out endwise when the table is run back clear.

The angle of the vees of planers ranges from about 90 deg. included, to 100 deg. and 120 deg., the latter for those of large dimensions. As in the lathes with vee'd beds, no gibbing is required, the vee's being self-aligning as they wear. And no tipping can occur since the pressure of the cut is uniformly downward. But many of the largest planers have one vee and one flat way, and others have two flat slide ways, in which case gibbing is necessary. The tables are boxed in the very heavy machines, in order to afford the highest degree of rigidity without excessive weight to be reversed, since the largest consumption of power occurs not during cutting, but at the instant of reversal.

In Fig. 47, some features to be noted are these: The lightening of the metal in the table round the tee grooves. This does not lessen its stiffness, while it removes metal that would cause curvature of the table in cooling. The bed has its outside faces flush with the outside of the ways, so bringing the ways within. Ribs support the ways along their inner edges. Many of the older beds had only one web thickness—a plate standing nearly centrally beneath the apex of the vee. Bosses for shafts are cast with the bed instead of being bolted on. The casting is an illustration, among many, of the present tendency to include as many details in one piece as is reasonably practicable, and of the avoiding any massing of excess of metal in any sections. The aim in all good designs is to secure the highest strength, and uniform shrinkages, with the minimum of metal.

Present Practice Anticipated.—It is interesting to note that in two details early planing machines anticipated present-day practice. The vee'd ways were used in Richard Roberts' machine (1817) now at South Kensington. The vees are inverted, that is, the apex is uppermost, as in the early and in many present-day lathes. They bear marks of the hand work done on them, which was the cogent reason why narrow vees instead of broad flats were used in the machines of that early period, a practice which continued until the planing machine was improved sufficiently to enable broad surfaces to be tooled. The table was traversed by a chain and winch, operated by a large cross handle at the side. The other detail occurs in the Whitworth planer of 1835, in which the tool was made to travel over a stationary work table, a practice that is retained in all the heavy pit planers to-day. The uprights, braced together, and carrying the cross-slide, were mounted on wheels that travelled along rails flanking the table, and situated below it. The wheels were like sheaves, vee'd in the grooves, and running on inverted vee'd rails. The uprights were moved along by large square-threaded screws, geared to rotate in unison, and automatically reversed. This pioneer machine also possessed the "Jim Crow" reversing tool-box for cutting on both strokes—long in use, and not yet entirely abandoned, notwithstanding the rivalry of tilting tool boxes, and the quickened speed of return non-cutting strokes.

A later planer by Roberts (1839) retained the inverted vee slide ways, and included a double cutting tool, not with a rotating box, but with two tools carried in a tilting box, several designs of which are in use now. He also introduced the

Fig. 47.

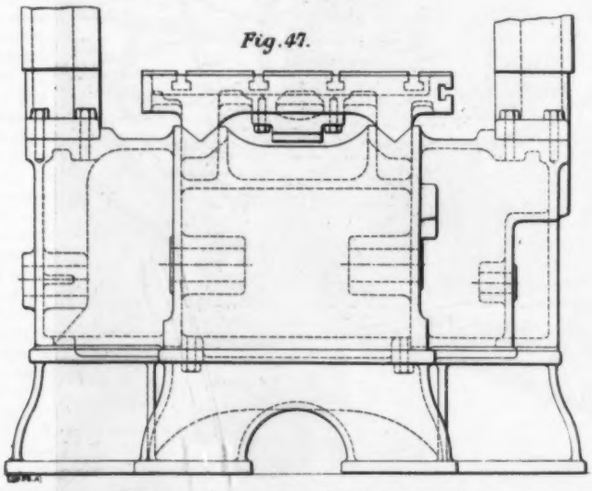


Fig. 48.

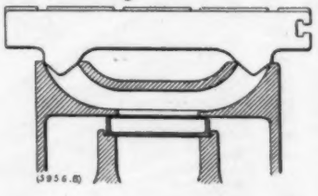


Fig. 49.

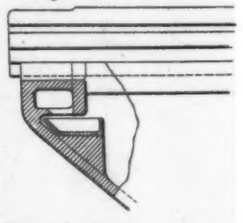
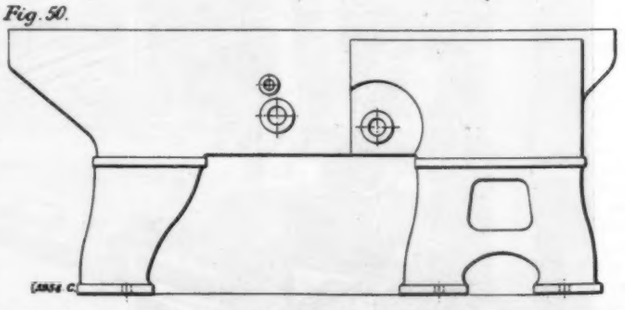


Fig. 50.



stepped rack for driving the table, a design which survives in some old machines, and was nearly universal a generation since. It has been abandoned only comparatively recently, in consequence of the practice of cutting the rack teeth instead of casting them, and of employing a large driving wheel—the "bull wheel"—instead of the small pinion formerly common. Bodmer, who invented, in 1839, the vertical boring mill—his "circular planing machine"—retained the vee path, not inverted, but recessed. He also invented a design of open-side planer in which the table travelled on recessed vees, but one was located on a higher plane than the other. This arrangement also is not uncommon.

Fig. 50 illustrates in outline a common form of the shorter planer beds, and legs. Long beds have three legs, those at the ends and one under the locality of the tool slide. Some makers bring the end legs flush with the ends of the bed, others of equal repute locate them some distance inwards as is done with the front leg. in Fig. 50. This seems a matter of opinion rather than one of any essential importance. The same practice is adopted in many lathe beds, with the object of shortening the length of beam unsupported between legs.

The drawings, Figs. 51 and 52, are those of a compact short-stroke planer bed, one of small dimensions, in which a shaper design of quick-return motion to the table is employed. The table measures 40 in. by 30 in. The link motion is enclosed within the bed, centrally underneath the table. The latter, Fig. 51, slides on flat surfaces, and is gibbed to internal vees, with an enclosed take-up strip, and horizontal setting screws. Brackets cast with the bed sides carry the housings which are bolted to vertical faces, and are supported on return strips. A single boxed cross-girt in front of the housings suffices, but at the front end where the ways overhang the foot, the end rib is stiffened by boxing its upper portion. Bosses at the base receive the rocking shaft for the slot link. To facings at the right-hand side, the bracket for belt-driven cone pulleys is bolted. The large boss above the facing receives the stem for the tool feed, coming from the main driving spur wheel. The dotted lines of the interior show the thicknesses of metal, which average about $\frac{7}{8}$ in. throughout. This is a fairly large casting, with metal equably distributed.

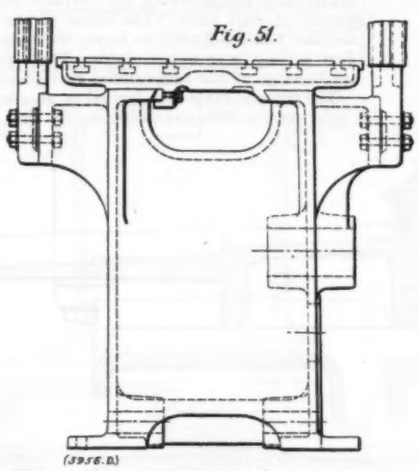
Side Planers.—The narrow guide has been fitted on side-planing machines. In one design it is situated along the front or inner edge nearest to the cutting tool, where the weight of the overhanging arm is taken. The other or opposite way is vee'd, the inner edge of the way being square, with a tapered adjusting strip. The flat ways are lubricated with cork rollers that float in oil reservoirs. The driving screw goes down the centre of the bed, and is supported along its whole length in a pocket which embraces about one-sixth of its circumference. In another machine the tool arm, Fig. 53, has the narrow guide taken on the hinder way, with a flat gib, and a take-up strip; the feed screw being located centrally. In later machines the saddle spans both shears, but its length is greatly increased to prevent twisting effects. Three different slide way arrangements have been employed therefore in this group of machines.

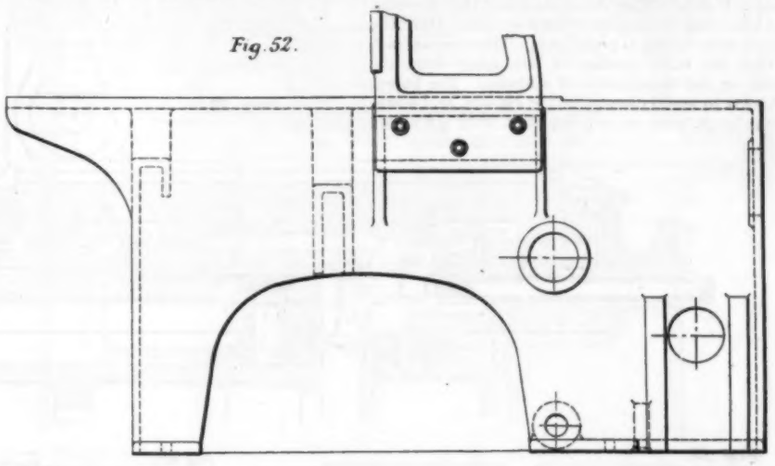
Shaping Machine Framing.—Fig. 54 is a side view of the main casting for a shaping machine—a hollow structure, with slides to carry the ram on top, and the long slide for the work table on the front. It is rectangular, with a broad foot, which is extended 15 in. at the front in opposition to the pressure of work being done on the knee. The ram moves in vees, with a setting-up strip. The apron that receives the knee table fits with a square edge and flat hinder gib above, and with a vee and setting-up strip on the lower edge. The lightening out of the portion of the casting that receives the apron slide will be noticed. A solid mass of metal here could serve no useful purpose, could not add to strength, and would set up strains in cooling.

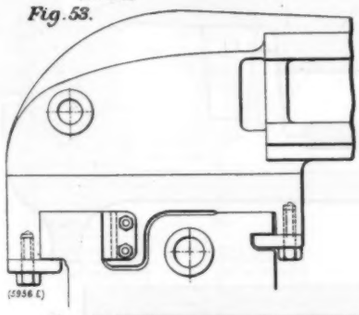
The interior of the casting is divided by a sloping diaphragm that closes in the chamber in which the slotted crank for quick return and its attachments are contained. It is fitted with a door at the rear. Waste oil falls on the sloping surface and runs down to the discharge hole at the bottom of the slope, closed with a screwed nipple. This prevents mess from accumulating on the floor inside the frame. Around the base, a useful waste lubricant trough, which avoids mess on the floor, is substituted for the older purposeless rounding, or ogee edge. The face that stands on the floor is reduced to a narrow margin, which is favourable to making a firm bedding.

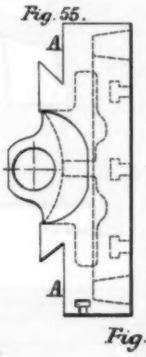
Milling Machines.—The drawings, Figs. 55 to 57, illustrate details that do not appear in photographs—the interior structure of the table of one of the Lincoln milling machines, by the Hendey Machine Company. A feature to be noticed is that the table has a wide bearing contact on the saddle on the faces A, A, that extend beyond the vee'd edges, so that work can be carried and well supported to the extreme edges without springing. The table fits to its saddle with a tapered gib.

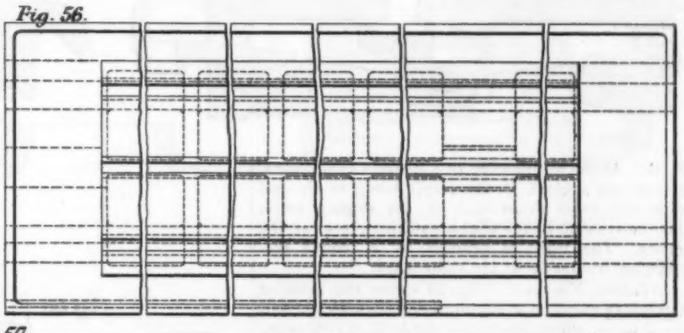
The design affords a good example of distribution

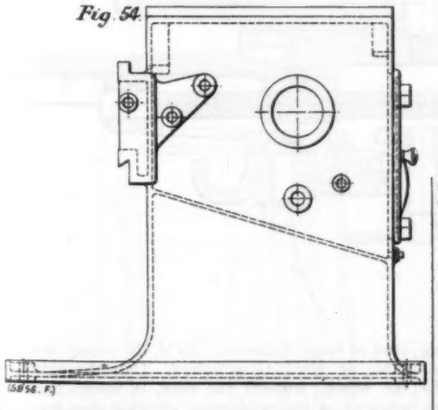


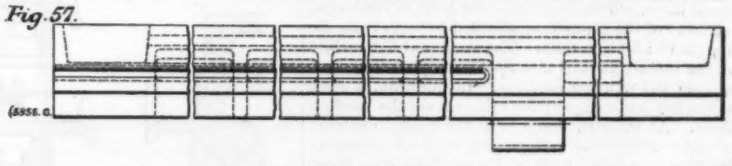












of metal, both to provide for rigidity while avoiding an excessive moving mass, and to ensure equal shrinkage strains. There is no marked discrepancy in the thickness of any section. The metal is recessed out under the outer tee grooves, Fig. 55. Stiffness is secured by the central longitudinal rib, and by the transverse ribbings. A deep oil trough is cast round the top of the table, and its encircling walls serve as stiffening ribs.

Fig. 58 is a longitudinal section through a "receding" table of a 10-in. automatic milling machine, by the Pratt and Whitney Company, of Hartford, Conn., U.S.A. The description of the machine and its action belongs to a later section. Only the unique table fitting is given here. The essential fact is that the table recedes or falls away from the cutter on the termination of a stroke. The object of this is to avoid damage to the cutters, and work. The table A, rests on inclined ways, with gib plates

Fig. 58.

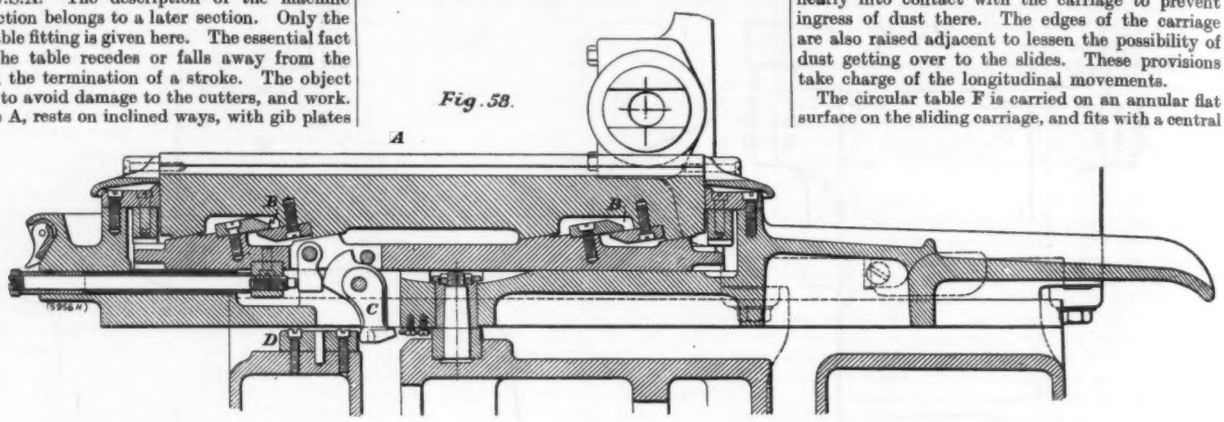


Fig. 59.

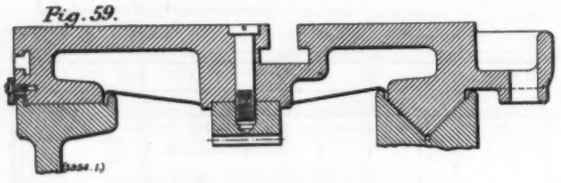
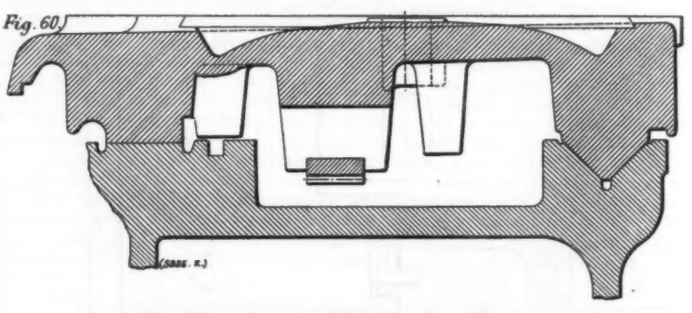


Fig. 60.



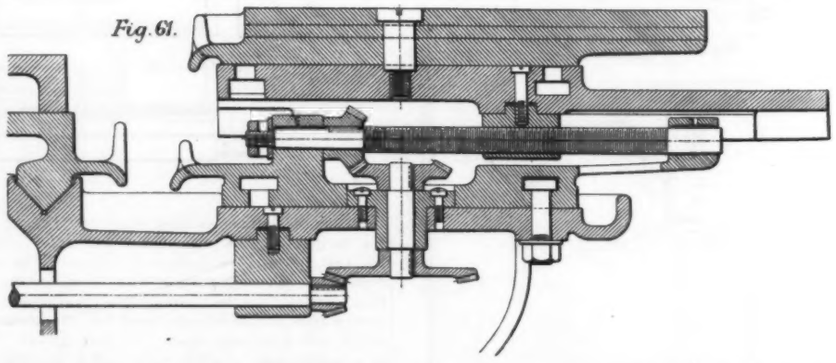
B, B. At the termination of a stroke a cam lever C encounters a block D, the result being to tip and slide the table downwards on its sloping ways. The movement is but slight, sufficient to clear the cutter. The table is drained by a trough discharging from a lip at the right hand.

Grinding Machines.—Fig. 59 shows the table of a grinding machine of standard design, with flat and vee'd ways, which illustrates methods of lightening out, and of the protection afforded to ways from the ingress of abrasive dust. The vees, and flat surface on the bed are flanked with upstanding beadings that enclose the wearing surfaces. In addition, a strip at the left-hand edge of the table covers the beading there. At the right-hand edge the waste lubricant trough extends far enough out to fulfil a similar function. Another section of a bed for a cylindrical grinder is shown by Fig. 60, having flat and vee'd ways, protected.

The illustrations, Figs. 61 and 62, are views of standardised forms of slides, and of the stand for the grinding wheel of an ordinary universal machine. The bracket that carries the mechanism is cast with the main bed, one vee'd slideway of which is seen to the left in Fig. 61, with a portion of the sliding table and the swivelling work table upon it. The machine is of that design in which the work is traversed past the wheel. The wheel bracket supports the swivel bed or base, the edge of which is graduated into degrees, 90 deg. each way from zero. This receives the wheel-feeding slide moving along and coerced against vee'd edges, Fig. 62, with a setting-up strip. This carries the swivel top—the wheel platen made of a diameter large enough to afford a bearing surface wider than the distance between the bearings of the wheel spindle (not shown), in order to provide ample steadiness to the wheel. The swivel is necessary to enable the operator to bring the edge of the wheel parallel with the line of travel of the wheel-feeding slide at all angles. The mechanism for actuating the wheel slide through bevel gears is obvious from Fig. 61. The complete protection afforded to the gears is apparent. A fact to notice in connection with the present subject is the provision made for carrying away the large volume of waste lubricant required in grinding operations. Each of the swivel slides has its oil troughs terminating in discharge spouts, whence the liquid falls, along with that from the work table into the trough that surrounds the bed and the wheel bracket.

An interesting link in the evolution of grinding-machine slides is shown by Fig. 63. Though it represents an efficient slide with ample protection, it has been superseded by the present design, in which a horizontal face is employed for the grinding wheel when the latter travels past the work. It is paralleled by the case of the front vertical, *versus* the horizontal slide base in the lathes. The fitting shown is by a vee on the bed and carriage, continuous except where the pockets occur for the oiling wheels and lubricant, the section being taken through one of these. The lower face of the carriage is supported against square edges. To the face of this travelling carriage, the wheel slide is fitted as shown with a vee above, and a vertical face below. A light web extends from the carriage to the work table, terminating in a lip to afford protection to the slides below. The operating rack and pinion are enclosed between the bed and the carriage.

Fig. 61.



One view of a Cunliffe and Croom supporting base, Fig. 64, for a disc grinder shows a hollow stable casting. A disc grinder is somewhat top heavy, and subject to vibration at high speeds. The design shows a broad base, well radiused, and a body tapering upwards, a reduction which is more pronounced in the other view that is not given. With metal only about ¼ in. thick, the large hollow casting is rigid enough. The interior is utilised for the storage of grinding wheels and tools.

Fig. 65 illustrates some excellent protective arrangements for a Blanchard grinding machine, using a rotary magnetic table. A is the base of the machine on which the carriage B slides with two flat faces, instead of the more usual flat and vee. Alignment is preserved by the fixed strip C on one side, and the tapered gib D on the other, which is enclosed with a strip E, similar to C on the opposite side. Both these strips have narrow plates screwed against their inner edges, and going downwards nearly into contact with the carriage to prevent ingress of dust there. The edges of the carriage are also raised adjacent to lessen the possibility of dust getting over to the slides. These provisions take charge of the longitudinal movements.

The circular table F is carried on an annular flat surface on the sliding carriage, and fits with a central stud of large diameter. To it the rotary magnetic table or chuck G is bolted. Only the outline of the chuck, without the coils, is shown here. So efficient is the protection afforded that ingress of dust is impossible. A deep ring standing up from the sliding carriage enters and fits nearly closely an annular recess in the bottom of the magnetic table, and this again is additionally sealed with a shallow annular tongue on the table entering a groove in the ring. The circular table F runs in a bath of oil retained between the base of the protective ring, and an inner ring that extends nearly to the under face of the table. Between this ring and the central boss the contact rings for the magnetic current are enclosed. The central stud in the boss is lubricated from a central oil well, distributing through a channel to a surrounding spiral groove. The waste lubricant used in grinding falls down into a settling pan H, and tank, which can be run out and withdrawn.

Fig. 66 is a section through the base and slides of the wheel head on a plain Brown and Sharpe grinder. The head, which receives the grinding wheel spindle, is carried on a narrow guide next the wheel, having an inner vee'd edge, and an outer square edge fitted with a tapered adjusting strip. The outer square edge has clearance and a flat gib to prevent tipping. The base for the head is bolted to the top of the main casting. The latter is provided with a waste oil trough, and it encloses the worm gear and spindle, whence the table rack is driven. The partitioned tank to the left contains the rotary pump, belt-driven, and carried with its spindle in a casting that fits within the opening at the top. The recess with the belt opening at the extreme left receives guide pulleys for the belt.

Fig. 67 is a longitudinal section through the slide that carries the cutter arbor of a Brown and Sharpe gear-cutting machine. The narrow guide is used, with vee'd edges, and a take-up strip. The other slide-way, to the left, is flat. The slide has clearance along the outer edge, and a return flange that encloses the gib. A is the location of the feed screw, B that of the cutter, whence it will be seen that the pull of the screw is about midway between the guiding surface and the resistance of the cutter—a balancing of stress similar to that which occurs in some other cases.

Portable Drill.—The base of a Tullis' portable horizontal drilling machine is shown by Figs. 68 and 69, page 270. Along its top face the upright member slides, and is adjusted with the screw. The stability of the upright is provided for by the width of straddle and by the extension of the foot beneath the drilling-spindle head. The narrow guiding principle is adopted, Fig. 68, with clearance next the edge of the other slide-way. The upright is gibbed at back and front. The worm gear indicated operates the horizontal adjusting screw, and is driven by a vertical shaft from a motor that actuates all the motions.

Specialised Designing.—The preceding illustrations have been those of examples from machines that are properly standardised products. Though modified in some details, they follow in the main well recognised lines. Lathes, planing machines, shapers, milling machines and so on preserve as a rule well crystallised outlines. But there is a large and ever-increasing number of machine tools that cannot be built on any preceding models, because the machines are characterised by novel features hitherto unrepresented. Every element, therefore, has to be designed with reference to its special purpose. Generally, too, now the aim is to include as many sections as possible in a single casting, in preference to the older practice of bolting brackets and minor fittings to a main casting. The anticipation of

Fig. 62.

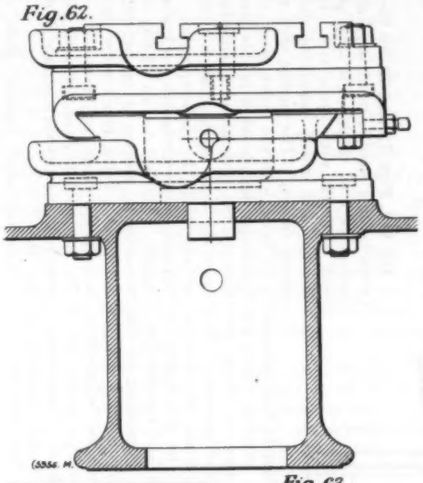


Fig. 63.

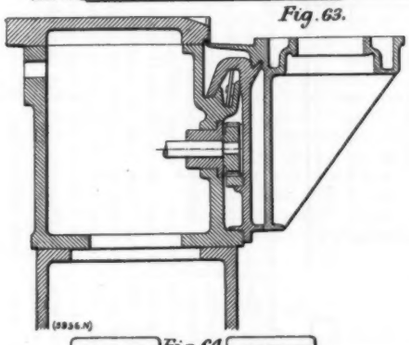


Fig. 64.

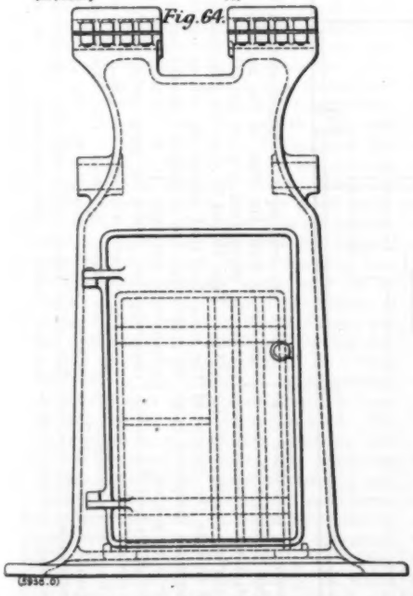


Fig. 65.

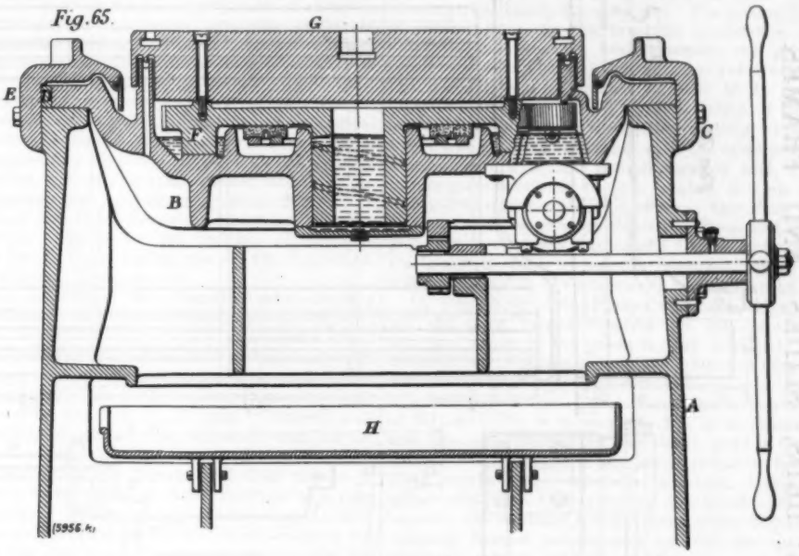


Fig. 66.

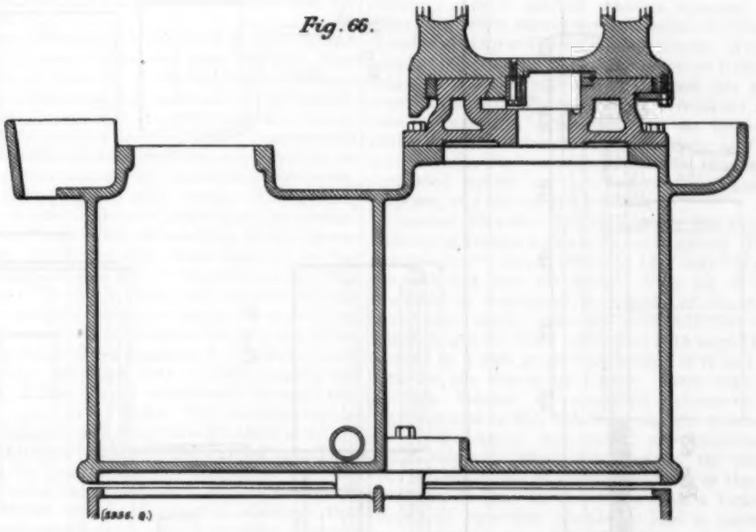
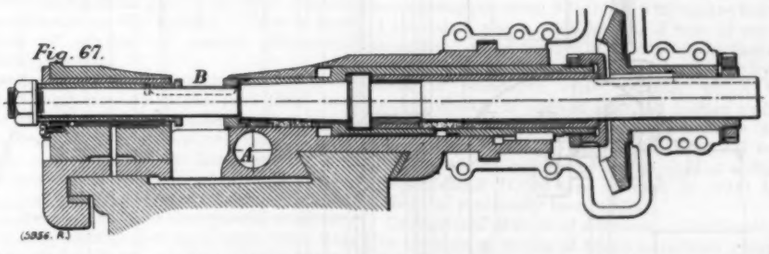


Fig. 67.



RECENT MACHINE TOOL DEVELOPMENTS; MACHINE BEDS, SLIDES AND FRAMES.

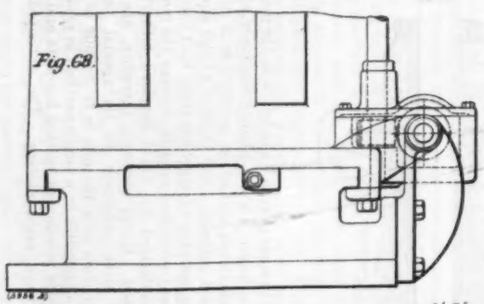


Fig. 68.

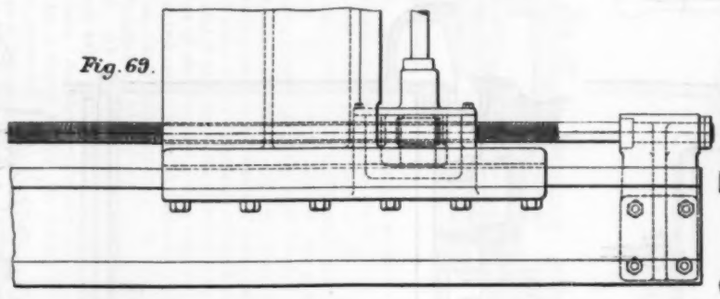


Fig. 69.

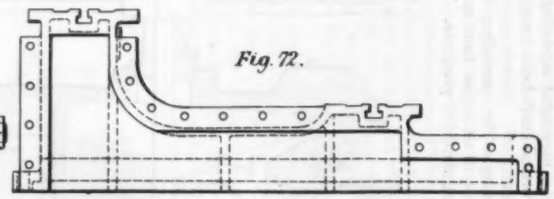


Fig. 72.

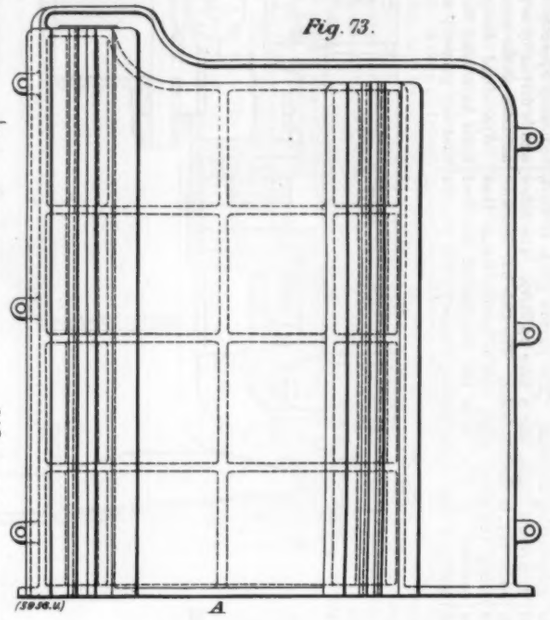


Fig. 73.

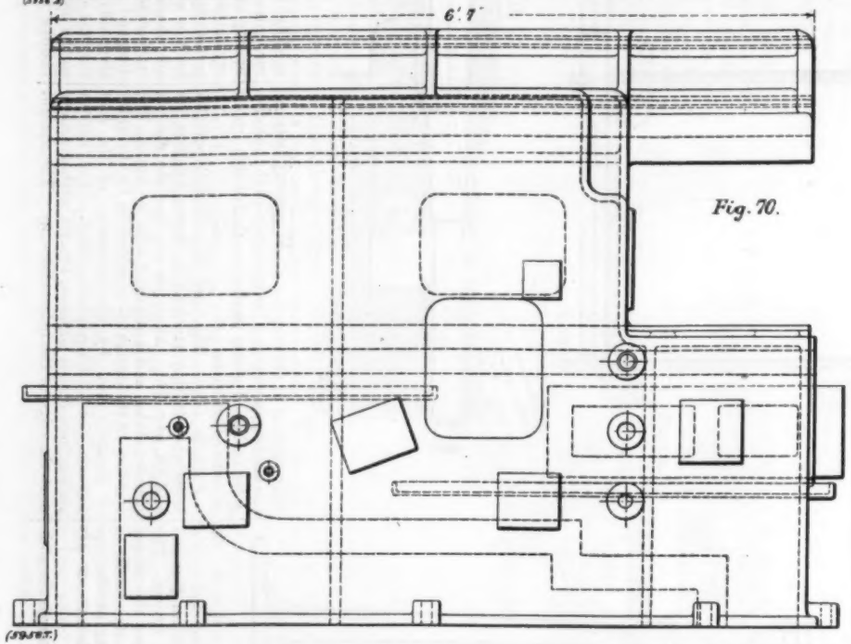


Fig. 70.

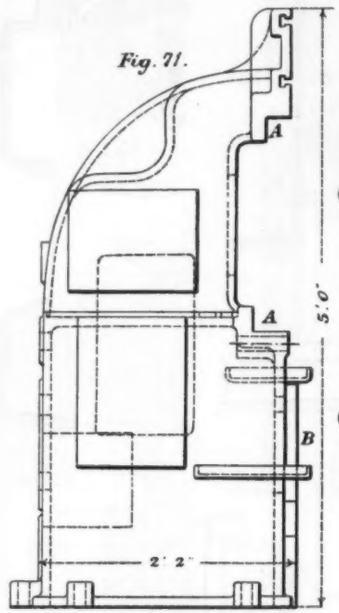


Fig. 71.

securing sound castings, even if somewhat large and complicated, is justified if sufficient care is exercised in careful proportioning, in the selection of suitable metal, and in correct temperature for pouring. It is always well to take the opinion of an experienced foundryman when designs of large and complicated castings are being got out.

Two examples of special design are here illustrated, being the beds on which the recent "Sykes'" patent gear-generating machine is built and manufactured by the Power Plant Company, Limited, of West Drayton. The design and operation of the machine will be dealt with at a later stage, but the illustrations detached are appropriate to the subject under present consideration.

There are two separate boxed castings bolted together to form the base of the machine. One carries the main driving gear, the other the work-saddle. Figs. 70 and 71 show the principal casting, the main bed that carries the cutter mechanism. Its proportions can be judged from the out-and-out dimensions inserted. It is boxed throughout, imparting the aspect of great solidity. Yet the thickness of metal averages only $\frac{7}{8}$ in., but sufficient to secure ample stiffness. The bracket for the driving gear is mounted on the upper vertical face of the casting, and is held after adjustment with tee-head bolts in the slots seen. To the vertical face below, the bed, Figs. 72 and 73, for the work-supporting saddle is bolted. Between these upper and lower faces there are two longitudinal recesses, A, A, of right-angular section, between which the reciprocating carriage slides, and on which two cutter brackets are mounted and adjusted. Flat gibs bolted against the faces retain the slide in position. Various facings for the attachment of brackets, bosses for shaft holes, and lugs for hold-down bolts will be noticed. Significant of the requirements imposed by heavy cutting, and its concomitant of ample lubrication, is the provision of an extended oil trough to receive waste. It is conterminous with the movements of the reciprocating slide. Another shorter trough surrounds a crank mechanism. These are cast with the main bed, which entails coring their interiors.

The bed, Figs. 72 and 73, for the support of the work-holding saddle, is of large area, with metal averaging 1 in. thick. The large plated portion is well stiffened with cross ribs. It includes two distinct and widely separated slide beds in one broad casting. The higher slide-way carries the work head, with the index gear; the lower way a tail-supporting bracket for the work arbor; not directly, but through an intermediate plate bolted up to the work head. This is necessary to permit of adjusting the tail-supporting bracket longitudinally, to accommodate work arbors of different lengths. The bed has an oil tray extending round two sides, the portion of tray beneath the adjustable tail bracket being much wider than the other to include the range of movement of the bracket. The vertical face A of the casting is that which is bolted against the vertical face B of the main bed, Fig. 71.

Moulding and Casting Beds.—Some of the examples of beds which have been illustrated would

furnish instructive studies in foundry work. Facilities for moulding, and the production of sound castings, not too costly to make; and free from internal strains, draws, camber, and other distortions and defects, are matters that must be regarded when designing. In Figs. 70 and 71 the moulding involves the employment of dried sand cores for the interior, and since the cores are massive, and the surrounding metal but moderately heavy, these should be partly broken up before the casting sets rigidly, otherwise it would become strained. The working face must be cast downwards where the cleanest metal is, and some portions of the cores must be carried on chaplets. Moulds for machine tool castings are usually made in green sand. Unless a sufficient number of castings were required to recoup the expense of moulding boxes specially made for turning over—and these would be excessively heavy with their included load of sand—the pattern for Figs. 70 and 71 must be moulded by bedding-in. The pattern must be boxed up, using stuff from 1 in. to 1½ in. thick screwed on cross-ribs. The shape is too awkward and the attachments are rather too numerous to permit of the construction of a skeleton pattern which is practicable in some cases in massive articles.

The pattern of the bed for the work support, Figs. 72 and 73, may either be boxed up and cored, or it may be like its casting, leaving the interior to deliver itself, the green sand cores or "cods" of sand being lifted on grids in the top. The first-named pattern would have a longer life than the second, and would be less liable to lose its pristine accuracy, but the cores add to the expense. If boxed up, core boxes must be made, and dry sand cores, to be hung in the top and resting on chaplets in the bottom. In either case the slide faces to be machined are cast downwards. The waste oil tray delivers itself readily.

Conditions of design, and of alternatives in pattern work and moulding, and of greater or less expense to be incurred, acquire greater importance when machines are highly standardised with a large production, than they do in the general shops, where only very limited numbers of similar castings are made.

ALKALI WORKS IN 1918.

IF the country had not long since learned almost to dread further inquiry commissions, it might be asked whether the time had not arrived to unite the various authorities to whose care the public welfare with respect to works and factories is entrusted. The complaints regarding alleged emission of noxious fumes mentioned in the fifty-fifth annual report on Alkali Works in 1918 suggests that question. A local authority charged the emission of acid vapour against a salt works; there was undoubtedly aerial pollution, but by black smoke and not by acid, and black smoke does not concern the Alkali Act. In another case crops had suffered by acid vapours, which might have come from some glass and glazed earthenware works near by, or from some alkali works further off. The latter, it was ascertained, did not emit illegal fumes, and the former are outside the Alkali Act, though they certainly give rise to acid discharges. In a third case allotments in the immediate neighbourhood of four large chemical works were alleged to have been damaged by the polluted atmosphere. The damage proved to be of a limited character, and there was no evidence to indicate the particular cause. "The position of these allotments was an unfortunate one, as even with full compliance with Act requirements there remains that latitude of escape necessary for the manufacturing operations involved." The discharge of something resembling chlorine from some shell-filling factory, in which occasional escapes were hardly to be avoided, will fall into a different category; but again we read that the Act did not apply. All this is unsatisfactory, though these and other cases were not considered sufficiently serious to institute proceedings for the recovery of penalties, where this might have been done. As a matter of fact, no proceedings have been instituted for a long string of years.

The number of works under the Act remained practically unchanged in 1918, there being 1,580 in the United Kingdom (comprising 166 works in Scotland) against 1,582 in 1917; the number of processes had risen, in England and Ireland, from 2,326 to 2,352, and Scotland adds 321 to the latter number. War conditions continued to exert their adverse influences and, as in the two previous years, there were only five inspectors available for the supervision of 10 English districts. On the other hand, the more extended employment of chemists in chemical works is a hopeful sign—that statement looks almost odd in the fifty-fifth report on Alkali Works—and an increased tendency towards co-operation by firms engaged in the same department of manufacture is also to be noted. Thus there is a movement towards the formation of a central laboratory for the tin plate industry of South Wales. In emphasising that the attainment of national prosperity will depend upon efficient labour, scientific control and co-operative effort, Mr. W. S. Curphey, the Chief Inspector, quotes some very opportune opinions on the training of chemists which Dr. T. Lewis Bailey, one of the inspectors, had expressed in his report.

Alkali and Copper (Wet Process) Works.—Passing to particulars, and following in the main the sequence of the report, we notice that electrolytic alkali and chlorine on the one hand, and the ammonia-soda process on the other, have so much developed that the operation of the Leblanc process was materially curtailed by the end of the year. Common salt will still be decomposed by sulphuric acid for the production of hydrochloric acid and salt cake, but to a much smaller degree, and that change is certainly to be welcomed in the interests of a pure atmosphere. We notice that the breaking of a salt-pot caused one fatal accident; the pot contents fell into a flue and drove the furnace flames into the stokehole.

Cement.—The output of the 46 (56 in 1915) cement works was much below the plant capacity, and repairs are so much in arrear that much will have to be done before a maximum output can be reached. As regards the potash recovery from kiln fumes little definite progress has been made; considerable quantities of the heavier dust were deposited in the flues and were utilised for agricultural purposes, but the finer particles still escape. The potash recovery in other industries looks more promising.

Smelting Works.—The 83 smelting works (seven more than in the previous year), behaved on the whole better than in 1917 as to acid fumes. But the district VIA (South Wales and Monmouth) sent such an excessive portion of sulphurous gases into the air (as much as 8·19 grains of SO_2 per cubic foot) that the total for England, 3·153 grains, was only slightly less than that of 1917, whilst the exclusion of this district would have brought the figure down to about 1 grain. The discharge is due to the roasting of zinc ores, the calcination of which is in many cases continued far beyond the stage necessary for the subsequent extraction of the zinc sulphate, while the condensation and utilisation of the sulphurous acid is disregarded, although the manufacture of sulphuric acid from those vapours is well-established in this country. There is thus both waste of sulphur and serious preventible atmospheric pollution.

Sulphuric Acid. I. Lead Chamber Process.—Some of the 146 sulphuric acid works (one plant was destroyed by fire) caused their owners much anxiety. When the abnormal war requirements ceased, several new plants erected on modern lines were not put into operation, others were stopped or worked intermittently, and labour and traffic conditions delayed the necessary repairs. Yet the general condition of the plants is considered to have improved. The new works designed for smaller chamber space continued to give satisfaction, but the combination of the newer and older types does not appear to answer; this is not surprising. The reactions in a new Opl plant, of 1¼ cub. ft. chamber space per pound of sulphur burnt per 24 hours, will occupy 12·3 minutes, against 16 cub. ft. and 144 minutes in an old chamber; in the Mills-Packard system (with external water cooling) the space ranges from 3·6 cub. ft. to 4·5 cub. ft., and the time from 50 minutes to 40 minutes. But a ratio of sulphurous gas to nitrous gas which is suitable for a reaction period of 40 minutes may be less appropriate for a time of 120 minutes. When the gas composition is adjusted so as to suit the small chamber, the gas may be too nitrous for the larger section, and *vice versa*, and even intermediate mixtures may not give the best results. Last year* the hope was expressed that a more thorough supervision and examination of the composition of the gases in process at successive points of the plant would come into extended use; that hope has hardly been realised. The production of nitrous gases by the catalytic combustion of ammonia has, however, been extended and gives much satisfaction, though it is not clear yet whether the method can in general be said to be less expensive than the old. The introduction of iron contact towers between the burners and the Glover tower has not been attended with the anticipated advantages. The dust carried forward with the burner gases continues to give trouble, in spite of the preliminary iron contact towers; this dust is in some cases removed in depositing flues, and the gases are then cooled, washed and filtered, and this treatment is said to answer. Another example will be noticed in our remarks on Scottish works.

II. Contact Process.—Pyrites and zinc sulphide are the main sulphur sources for this process, and the purity of the gases is very essential to maintain the efficiency of the plant. Some elaborate and costly purification plants have proved disappointing, however; as a result the conversion of SO_2 into SO_3 is incomplete, SO_2 is discharged into the atmosphere, and the oleum yield is low. On the whole, however, the aerial pollution from these works was materially lessened. Gaillard towers still leave a good deal to be desired in that respect; the modified Kessler concentrator and the ordinary Kessler concentrator as well are quite efficient; about cascade systems opinions still differ; the Davis concentrator is useful for bringing chamber acid up to Glover-tower strength. For the purpose of removing suspended particles from the acid the Calder-Fox scrubber, mentioned last year, is recommended. The one fatality reported is a case of arsenical poisoning, due to inefficient ventilation of a tank in which sulphuric acid had been stored; such a tank should be thoroughly ventilated before any one enters it for cleaning purposes, and also while he is in it.

Chemical Manure.—The decrease in the number of chemical manure works has come to an end. There were 164 such works in 1909; by 1917 only 138 were left, but last year the number went up to 142. It should be mentioned that many of the closed works were small, while the survivors had been enlarged, and the brisk activity of 1918 might have resulted in a still greater production if it had not been for the dearth of labour. Nitre cake will probably become a permanent substitute for sulphuric acid in this industry, and the extending use of mechanical dens seems advantageous in several respects. Mention is made of the Sturtevant den plant and of the new features of the Hill and Eden design. In this latter type a mixer in continuous operation discharges into a series of four rectangular dens, 9 ft. high, 5 ft. square below, 4½ ft. square above, each holding 3 tons of superphosphate; when one den is filled, the false bottom is wheeled away on a trolley and replaced by a screen of pianoforte wires, through which the superphosphate is pressed into the hopper underneath it. The imports of superphosphates had risen in 1918 to 464,747 tons, against 333,371 tons in 1916, whilst imports of guano and of sodium nitrate (about 21,000 tons of each in 1916) had entirely or practically been stopped.

Sulphate and Muriate of Ammonia. Gas Liquor.—The number of works of these important groups, 743 (742 in 1917), was composed of 632 sulphate and 111 gas liquor works. The total ammonia production (expressed in terms of sulphate with 24·5 per cent. of NH_3) amounted to 432,557 tons, gas works supplying 173,451 tons, iron works 12,717 tons, shale works 58,311 tons, coke oven works 164,448 tons, and producer gas and carbonising works (bone and coal) 23,534 tons; the total was by 26,000 tons smaller than in 1917, and by about 1 ton smaller than in 1916. The figures comprise Scotland. Towards the end of the year the demand for concentrated ammoniacal liquor (for munition

* See ENGINEERING, August 9, 1918, page 150.

works) diminished, yet 121,681 tons of the total given were manufactured as this liquor. The reduced production of ammonia sulphate, which shows most in the gas works figures, is ascribed to the inferior quality of the coal used in many works, to the use of water gas, the large production of gas per ton of coal carbonised, the use of steam in vertical retorts, the demand for concentrated ammonia and the working loss of this product, and finally to a general reduction in the quantity of gas consumed. It must not be overlooked that, though a large production of gas per ton carbonised and the use of steam in retorts may increase the recovery of ammonia per ton of coal, yet, if the weight of coal used is more than correspondingly less, an increased recovery per ton of coal will be associated, on a similar gas consumption, with a decrease in the actual quantity recovered. Of the 16,540 coke ovens in use in 1918, 7,013 were of the beehive type, 2,217 Otto-Hilgenstock ovens, 1,750 Simon Carvès, 1,415 Coppée, 1,361 Koppers, 1,357 Semet-Solvay, and 1,427 of unnamed types. Mr. Curphey draws attention to the fact that, besides the 7,013 old beehive ovens, all the other types (including certainly some of the unnamed) represent foreign designs; prior to the war the recovery plants seemed to have got under foreign, largely German, control, but important additions have been made to these works by British effort and British material. Two fatal cases of gas poisoning, the one due to ammonia itself, the other to the gas mixture from a still, are reported; one of the victims was a woman; on the whole women have proved efficient in ammonium sulphate plants.

The researches on the "direct ammonium sulphate process," to which the last three reports devoted much attention, are being continued in conjunction with several works, and 20 out of the 81 pages of the report deal with these researches, and especially with the "backward rotation system" working with a downward flow of the gases, which has since 1915 been under trial chiefly in the gas works figuring under the letter E in the reports. The general working losses of ammonia remain high in some plants, and it is confirmed that too little attention is paid, in the distillation of the virgin liquor, to the due adjustment of the lime and liquor feeds. The bubbler and the gas purifier likewise claim close attention; where the process is properly studied and supervised, however, it improves the yield. In one plant Mr. Curphey is enabled to state, the yield of ammonium sulphate was raised from 13 lb. to 17 lb. through the influence of his reports. We shall presently give some further figures. A general summary of the researches is not yet offered.

In an appendix of 31 pages, Mr. Linder—the Chief Inspector's assistant, who also takes a share in the supervision of the 10 districts—deals with the analysis of liquors of exceptional character such as the demand for concentrated ammonia has made commercial; the need for further investigation had last year been shown by the researches of Dr. H. G. Colman and Mr. E. W. Yeoman.

As regards the Cobb process for the manufacture of ammonium sulphate without the use of sulphuric acid, Mr. Littlefield (Inspector of the East Midlands district IVa) reports that Professor Cobb aims at utilising the sulphur in the coal, by passing the gas through a centrifugal washer containing zinc sulphate. Zinc sulphide is thus precipitated, and ammonium sulphate is formed and gained by evaporation; the sulphide is roasted, and the SO_2 liberated absorbed by zinc oxide, suspended in water, and the zinc sulphate is thus restored; the process is now being tried in a new plant.

We mentioned above that inferior coal has been used. With respect to this point and to the complaints about the unavoidable working losses, which the manufacture of concentrated ammonia is alleged to involve, a quotation from a letter which Mr. W. B. McLusky, of Halifax, sent to the Chief Inspector, is very gratifying. The concentrated ammonia available in 1918 for sale in Mr. McLusky's works was equivalent to 30·54 lb. of commercial sulphate (of 24·5 per cent.) per ton of coal carbonised, as compared with an average of 25·31 lb. for the ten years previous and 24·78 lb. for the year 1917. That increase, Mr. McLusky stated, had been obtained in spite of admixtures of 31·9 per cent. of Durham coal, which arrived irregular in size, and varied much in ash and in quality generally, so that the ammonia production fluctuated considerably. The coal being very dry, water spraying was resorted to, and the improved returns are attributed to the damping of the coal and coal dust which rolls the powder into moist nodules. The charge of coal in the retort was thus kept more open, and a protective steam envelope was provided between the gas and the hot retort walls. Mr. Curphey points out that the influence of the use of steam on the ammonia production had long been recognised, and he ascribes the high yield to the efficient plant and to the accumulated experience.

How nitre cake is utilised in the Llwynpia works of the Glamorganshire Coal Company is described by Dr. Fryer, the Inspector of district VIa. A lead-lined box with lid and steam coil is all the additional plant required. The solution of the nitre cake in water containing 6 per cent. of sulphuric acid is fed into the saturator; ammonia and steam or ammonia and coke-oven gas enter the saturator; the ammonia is absorbed, sodium sulphate is deposited, and some of the mother liquor is ejected by the back pressure into a well where on cooling the ammonium sulphate crystallises, whilst the liquor of bisulphates, &c., is again injected into the saturator.

Nitric Acid, Chlorine, Muriatic Acid.—The production of nitric acid diminished considerably, and the number of works was reduced by five, to 96. Although the ammonia oxidation has extended, most nitric acid works still decompose sodium nitrate. The increase of the chlorine works from 30 to 32, is merely a question of the registration of works in which liquid chlorine, received in cylinders, is used; that the electrolytic chlorine works are in the ascendant has already been mentioned. The number of muriatic acid works also increased, from 66 to 69, and improved wool-carbonising machines are coming into wider use, But the tin-plating industry was restricted in its operations as to labour and raw materials; hence less tin flux had to be dealt with, and the atmospheric pollution was less severe. In the steel pickling departments nitre cake is replacing muriatic acid prior to tinning.

Sulphide, Bisulphide of Carbon, Alkali Waste. Arsenic. Picric Acid.—The sulphide works decreased by three, to 98. But some dye works in which sulphur (instead of metallic sulphides) react with organic substances, do not come under the Act, though sulphuretted hydrogen may be evolved. The three reported cases of poisoning by this gas were not fatal. The number of alkali-waste works (9) has not changed for some years, but will probably go down owing to the adoption of electrolytic alkali processes which do not accumulate alkali waste. The five carbon bisulphide works (likewise an unchanged number) were very active; pollution was kept within legal limits, however. The high prices of white arsenic led to an increase (by 7) of the arsenic works (to 52); one of these gave reason for serious complaints. The reports by Dr. Fryer again prove that dry filters are more efficient than wash towers for arresting arsenious acid, though both methods yield satisfactory final escapes. The requirements of picric acid have become very small since the armistice, and the number of works fell from 21 to 15; the further adoption of nitric acid towers had already reduced the proportion of noxious gases from these works, about which there was much complaint last year.

Tar Works.—Tar works have been on the increase throughout the war, and their number rose again by 15, to 375, in 1918. Yet, owing to transport and labour difficulties, demands could not be satisfied in some places, whilst elsewhere stock accumulated. In two works plants for the continuous distillation of tar down to pitch were in the course of erection; other distillation plants and dehydration plants also increased, but the production totals are nearly the same as in 1917: tar distilled in gas and coke-oven works 1,510,065 tons, in other works 131,325 tons; pitch produced in the former works 720,572 tons, in the latter 71,237 tons.

Alkali Works in Scotland.—To these figures have to be added the tar totals from Scotland, which are not combined in our statistics so far given unless otherwise stated, because the report of the District Inspector, Mr. J. W. Young, is kept apart from the other report. As regards tar production it is further noteworthy that in England 195 gallons of tar are reckoned equal 1 ton, whilst the usual ratio in Scotland is 200 gallons to the ton. In the following figures of Scotland's tar production in 1918 the 195 gallon basis has, however, been adopted: tar distilled in gas and coke-ovens works 142,200 tons, in other works 120,549 tons; pitch produced in the former 67,110 tons, in the latter 66,790 tons. The pitch production of Scotland went down in 1918, about 3,000 tons; the tar distillation figures varied very little. As regards other statistics we notice that the pyrites burned in 1918 (1917) amounted to 131,372 tons (146,030 tons); mineral phosphate and bones dissolved to 76,800 tons (64,150 tons); ammonia sulphate products totalled 110,512 tons (118,427 tons), 21,771 tons being from gas works, 11,861 tons from iron works, 58,311 tons from shale works, and 18,579 tons from producer gas, coke and carbonising and bone works. [These figures were included in the ammonia statistics above given for the United Kingdom.] Concentrated ammonia was manufactured to the equivalent of 24,707 tons. With respect to the different branches we have little to add. The mechanical furnaces of alkali works worked well and economically; smelting works were restricted by want of raw material, and very slow progress was made in new plant. The addition of an iron contact tower between the burners and the Glover tower of sulphuric acid works reduced in one case the nitre required by one-third, a very satisfactory result, whilst one platinum-contact plant caused so much trouble by discharge of acid gases that operations were discontinued.

The cases of the collapse of thick-walled cast-iron vessels (mixed-acid eggs) mentioned by Mr. Young were referred to in a recent paragraph of ours in connection with a paper by Dr. A. C. Cumming,* from which Mr. Young quotes. Chemical manure works decreased by one in number, to 30, but increased their output considerably, and the 76,800 tons of phosphates and bones dissolved, stated above, are, in fact, the highest ever recorded in Scotland.

One general remark occurs to us in concluding. Mr. Curphey states in several instances that he owes the statistics given to the courtesy of manufacturers. This is in itself satisfactory; but H.M. Chief Inspector under the Alkali Act ought to be in a position to command official statistics.

Magnetic Gearing and Escapements.—The magnetic gearing which Pierre Sève described last winter in the *Comptes Rendus*, vol. 167, pages 181 to 183, is not really a novelty since magnetic clock escapements have often been proposed and found open to objections; but he claimed that his electric pendulum of the Lippmann type which is magnetically geared with the wheel train has operated regularly for several months. He did not give mechanical detail, but discussed rather general features of magnetic gearings. He places n magnetic needles along the sides of a polygon of $2n$ sides, consisting of a disc of non-magnetic material; or he arranges $2n$ needles radially in the polygon; or he mounts the $2n$ needles vertically to the plane of the disc. These magnetic wheels would correspond to wheels with n teeth and would act upon one another like ordinary gear wheels with flexible teeth. The coupling is thus somewhat of the type of coupling between the field of an electric machine and its rotor; and properly arranged, the geared wheel should run as uniformly as the primary wheel.

The Wireless Society of London.—The Committee of the Wireless Society of London met on July 24, under the presidency of Mr. Alan A. Campbell-Swinton, F.R.S., with a view to an early resumption of activities. The Hon. Secretary, Mr. R. H. Klein, having resigned and having been elected an acting vice-president, Mr. Leslie McMichael, of 30, West End Lane, West Hampstead, N.W. 6, was elected hon. secretary, and to him all communications should be addressed. Intending new members and those who were members at the outbreak of war who have changed their address, are requested to communicate with the Hon. Secretary. The society is open to all those interested in the study and furtherance of wireless telegraphy, amateur or professional. The society is at present in communication with the Post Office on the subject of licences. The finding of new club rooms is engaging the attention of the committee, and it is hoped to secure premises where the wireless equipment of the society can be installed and used. A general meeting will be held in a few weeks' time of which due notice will appear in the Press, and will be sent to members and those who anticipate becoming members.

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* Engineering, June 13 last, page 790.

INDUSTRIAL NOTES.

With regard to the points raised by the Prime Minister in his speech on Monday, August 18, Sir Vincent Caillard, President of the Federation of British Industries, makes the following statement:—"The Federation are in entire agreement with the Prime Minister in his description of the industrial situation. It is vital that every one must pull together, both employers and employed, disabusing their minds of the suspicions which, to some extent, still exist, unfortunately. The whole community must act in that splendid spirit which animated all classes during the war. The matter is not merely an employers' question, or a workers' question, but a matter concerning all. It is certain that members of the Federation of British Industries will do everything which lies in their power to answer the urgent national call. Everything depends upon production, which, in turn, depends largely upon the method in which such questions as the future trade policy of the country and nationalisation are dealt with. So far as the mining industry is concerned, it is impossible to give any definite views on so general a statement as that made by Mr. Lloyd George, but the rough outline given by the Premier will, doubtless, appeal to the great body of sensible opinion. Particularly with regard to the removing of import restrictions, everything must depend upon the measures taken by the Government with regard to anti-dumping and protection to be afforded to important industries. It is thought regrettable that the Government have not taken definite action in these matters before removing the import restrictions, as manufacturers and producers are left in a state of doubt as to what the future will be, and there is considerable risk in spite of the automatic protection which the Premier stated was given by exchanges and freights, that production will be disorganised to a great extent and unemployment consequently increased, till such time as Parliament can pass definite measures to meet the situation."

The dispute between the co-operative societies and their employees in Lancashire and surrounding districts, which had resulted in a lock-out and strike, was settled early last Sunday morning after a conference between the Amalgamated Union of Co-operative Employees and the Federation of Hours and Wages Boards. The conference, which lasted more than 24 hours, was brought about through the intermediation of the Manchester and Salford Trades and Labour Council. The trouble arose in connection with a demand for improved hours and wages which was backed by the serving of notices of the withdrawal of labour to various of the co-operative societies by the employees' union. The societies replied to this by serving notices of a lock-out, which had the result of causing many of the employees immediately to leave work. Some of the co-operative societies which were not members of the Federation of Hours and Wages Boards were not affected and others appear to have carried on negotiations with their workpeople. Further, the whole of the employees did not leave work at one time and ultimately the situation became confused and somewhat obscure. A great many of the co-operative societies' premises and shops were, however, shut down and considerable inconvenience caused to their members. As a result of the conference of last Saturday and Sunday a 48-hour working week all round has been agreed on with overtime at the rate of time and a quarter for the first two hours and time and a half after, with double time for Sundays. There is to be an increase of wages all round. This is not the first disptue which the co-operative societies have had with their workpeople, but coming at the present moment it is a useful reminder that workpeople turned employer find the same difficulties with labour that the more ordinary breed of employer meets, and that the present talk of nationalisation, co-operation, representation of labour on management and all the rest of it, contains no cure for labour ills and little promise of any improvement on existing affairs.

A curious strike took place last week at the Aston Cross, Birmingham, works of the Dunlop Rubber Company. A section of the employees in the rubber department some short time ago submitted a demand to the firm for payment of a special rate for night work. On the Thursday morning they applied for this rate to be immediately granted, and on this being refused 9,000 to 10,000 hands immediately ceased work. The attitude of the firm was that the demand was presented at such short notice as to prevent it being considered, that it was put forward irregularly, and that no communication of any sort in connection with the matter was received from any trade union. As a result of the strike the rubber departments of the works were closed. The strike was apparently engineered entirely by non-union men, but many members of the Gas, Municipal and General Workers' Association and the Workers' Union joined the strikers. Officials of these unions accordingly got in touch with the firm and were later able to announce to a meeting of the strikers that the Dunlop Company were quite prepared to discuss the matter if it were brought forward properly by one of the unions, and further that the firm wished the whole of its workers to become organised so that it could treat with their accredited representatives in case of dispute. The strikers agreed that if the works were opened work would immediately be resumed. The officials of the Gas, Municipal and General Workers' Association and the Workers' Union conveyed the following resolution to the firm:—

1. That we, the members of the above societies, return to work on Monday morning, the 25th inst., on the conditions laid down by the firm, upon the understanding that the firm will in future only negotiate with trade union officials on matters which have now been settled within the company's organisation, and will give each of the workpeople who are in their employ full facilities and encouragement to join a trade union, and will also, upon engagement, request workpeople to declare the union to which they belong, and, if they are not members of a union, to make their engagement subject to their membership of a union within 14 days. We think this is the only safe method by which we, as loyal workers and trade unionists, can be assured of continuing our employment, and we greatly resent being on two occasions recently fetched out of our work by non-unionists. But we give all these men a cordial invitation to join the union.

2. That we, the members of the above societies, deeply deplore the action of the non-unionists and unofficial strikers, and request our officials to convey this to the management at Messrs. Dunlop Rubber Company, Limited.

On the strength of these resolutions the firm decided to re-open the works, and work was resumed last Monday.

Dealing in a special article in the *Daily Chronicle* with the labour organisation which is to be set up in connection with the League of Nations, the Right Hon. G. N. Barnes says that the labour organisation will draw up conventions and recommendations for submission to the competent authority of the nations which are members of the League of Nations. By these means it is hoped and believed that a most necessary and wholesome check will be given to competition of countries in which labour is sweated and oppressed.

This will not only benefit the peoples of these backward countries, it will raise the standard of life everywhere. How often have employers in countries of comparatively high wages urged foreign competition of the low-wage countries as one obstacle to improvement? The argument may not have been sound; employers may have had full value for relatively higher wages by relatively greater efficiency. But it has sometimes been effective. Hence the need for concurrent advance in all countries.

If Great Britain advances in its standard of wages only in the same degree as compared with Japan, then British employers are in no worse position as compared with Japan than before such advances. If India raises her starting age of children in industry to the same extent as America, then they both occupy the same position in the world competition as before the changes were made. If women and children are protected everywhere from excessive work and poisonous processes, then no change is made to the detriment of any one country.

An important letter, dealing with the question of increased production, has been written by Mr. J. T. Brownlie, Chairman of the Executive Council of the Amalgamated Society of Engineers, to Mr. C. W. Bowerman, M.P., Secretary of the Parliamentary Committee of the Trades Union Congress. The letter is as follows:—

"My dear Bowerman,—I trust you will pardon the liberty I am taking in addressing you thus. The national situation is very grave. A considerable amount of misapprehension exists in the minds of the trade unionists throughout the country in regard to production. Mr. H. Hoover, in an analysis on the economic situation of Europe says:—

"'Unless productivity can be rapidly increased, there can be nothing but political, moral and economic chaos, finally interpreting itself in loss of life on a scale hitherto undreamed of. . . . No economic policy will bring food to those stomachs, or fuel to those hearths that does not secure the maximum production. There is no use of tears over rising prices; they are to a great degree a visualisation of insufficient production.'

"The trade union movement is more powerful to-day than at any period of its history. With power comes responsibilities, and however much we may reject the criticism of those who are not trade unionists, we cannot evade our responsibilities to the community. The economic situation of this country and of Europe is very grave, as emphasised from the above excerpts, and it appears to me that responsible trade union representatives must do something to alleviate the situation on behalf of the workers of the nation.

"The Parliamentary Committee is the most representative and responsible body of trade unionists in the country; therefore I consider it is incumbent upon your Committee to take some action with a view of alleviating the situation. The condition precedent in that direction appears to me to be the dissemination of accurate and reliable information. The mere raising of nominal wages, without an increased production in the necessaries of life, is no solution of the difficulty. It is unnecessary for me to say anything further at this juncture, as I consider that the members of your Committee are equally alive to the gravity of the situation.

"Trusting that your Committee will appreciate the advisability of taking immediate action to effect some amelioration in the gravity of the position in which the nation finds itself.

"I am, yours faithfully,

"J. T. Brownlie."

Every one must welcome this letter. Much, of course, has been written and said on the matter of increased production, but it is to be feared a considerable part of it has not reached the classes most concerned. As the Trades Union Congress meets on September 8 next one may take it that the letter will come up for discussion, and so be brought to the direct notice of the representatives of the rank and file, and through them to the workpeople themselves.

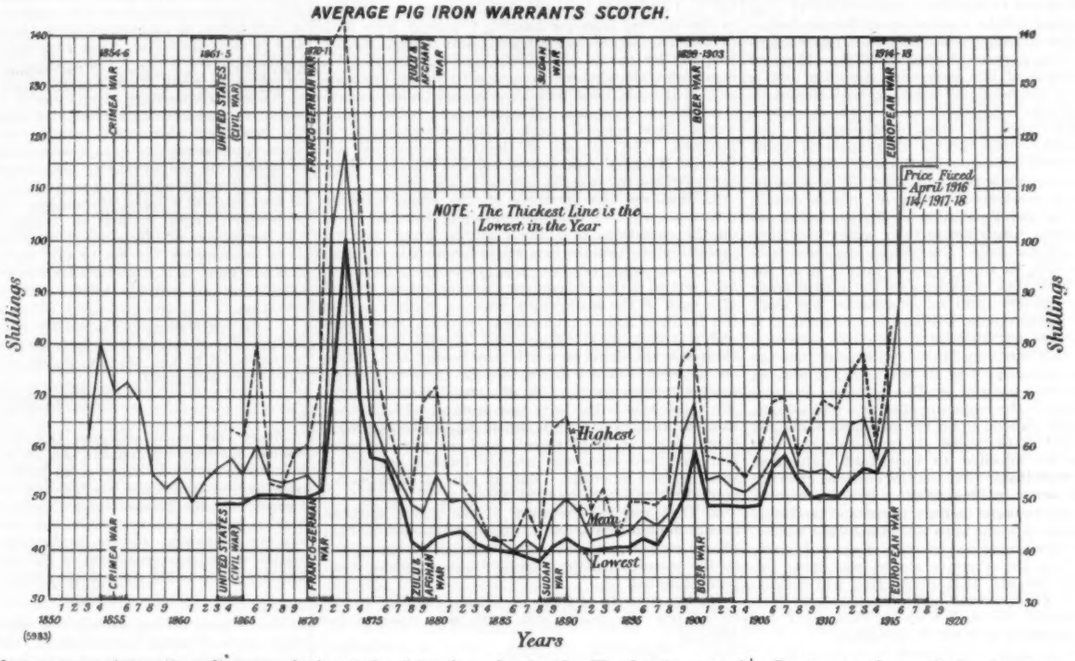
The report accompanying the eightieth balance-sheet of the General Federation of Trade Unions, contains the following pregnant sentences from the pen of Mr. W. A. Appleton, the General Secretary:—

"Political strikes must either fail or end in revolution. They are not against the capitalist, but against the community. It is not the capitalist who suffers, but the people. Against such strikes the Government must protect the people or it must surrender its functions. The effect of such strikes is to decrease production and increase the price of all commodities.

"In view of the national situation and the possibility of a grave shortage, it is imperative that trade unionists should face the facts. The outstanding ones are that the war is over; that competitive laws as between nations are now forcefully operating; that food and raw materials required for the sustenance of the men and women of Britain must be bought from countries over whose merchants our Government has no control; and that these commodities must be paid for with goods, and not paper. November, 1919, to May, 1920, will be fateful months; unless sanity returns and production increases they will be tragic months."

The Federation of Civil Engineering Contractors.—A federation under the above name has recently been formed, and the members of it constitute, we are informed, practically all the large civil engineering contractors in Great Britain. It will be appreciated that the present industrial situation, as well as the important reconstruction work to be carried out in the near future, calls for the formation of a body to represent interests which are at present entirely unrepresented by any existing association of building or public works' contractors. Contracts entered into by the members of the above federation are in many cases of very long duration and of very large scope, and firms who enter into such contracts have necessarily to look forward to periods several years ahead, in regard to which it is extremely difficult, owing to the existing state of things, to make any definite or clear prognostications. The main object of this federation we are informed is to act collectively through an elected council in relation to the professional institutions and public authorities, and to deal with trades unions and other labour organisations in regard to hours of work, rates of pay and all other matters appertaining to the employment of labour. This latter work must necessarily include a participation in the work by Conciliation Boards which may be already constituted or whose constitution is now in contemplation. The first council elected at the first general meeting on June 30, is as follows:—President: Viscount Cowdray, P.C. Vice-presidents: Sir John Jackson, C.V.O., and Mr. James Railton, C.B.E. (Topham, Jones and Railton, Limited). Members: Messrs. H. C. Baldry (Baldry, Yerburgh and Hutchinson, Limited), H. F. Brand (Charles Brand and Son), C. R. Hemingway (Logan and Hemingway), T. Wilson Lovatt (Wilson Lovatt and Sons, Limited), Gerald G. Lynde (Edmund Nuttall and Co.), T. Malcolm McAlpine (Sir Robert McAlpine and Sons), T. Tyson Middleton (Walter Scott and Middleton, Limited), J. Harry Price (John Price and Sons), and Sir E. W. Moir, Bart. (S. Pearson and Son, Contracting Department, Limited). The secretary is Mr. E. J. Rimmer, and offices have been taken at 40, Broadway, Westminster, S.W. 1.

THE EFFECT OF WARS ON THE PRICE OF SCOTCH PIG IRON.



We give above a very interesting diagram, for which we are indebted to Mr. Andrew Hamilton, M.Inst.C.E., of Liverpool, showing the influence of Wars on the price of Scotch pig iron. The data plotted range over a period of sixty-six years, and include the effects of the Crimean War, the United States Civil War, the Franco-German War of 1870, the Sudan War, the Boer War, and the great European conflict just brought to an end. The results are very striking, and the comparison which can be made between the prices of 1870–73 and those of the last four years are of particular interest.

ELECTRIC MACHINERY CONTROL.

It is a good thing that even the ardent advocate of an entirely new type of machinery, utilising untried forces, rarely foresees all the difficulties that the adoption of his proposals will involve. When the light of the first arc lamps dazzled the admirers of the new illuminating agent, few people clearly grasped the seriousness of the problem of a subdivision of the electric light—a problem so completely solved long since that the young electrician of our days hardly knows that it ever was a difficult problem. Electric power transmission seemed equally simple and easy; yet modern switch panels look anything but simple, and many a workshop superintendent would probably have hesitated to replace the steam engines, belts and shafting of his shop by electric motors and wires if he had understood what the electric control would really mean. By the time that he can draw the balance and consider the saving in power, labour and time, the perfect control and ease, and the cleanliness and neatness which he owes to electric installation, he will not regret his decision.

That there remains still sufficient scope for ingenuity in the design of self-acting motor starters and machinery control devices in general, is not due to the imperfections of electric appliances, but to the fact that our claims grow as we recognise the superior possibilities of electric drives. The great activity in this field was quite manifest at the recent British Scientific Products Exhibition. We briefly mentioned, on that occasion, on page 14 of our issue of July 25 last, some of the novelties of the Igranic Electric Company of 147, Queen Victoria-street, E.C. Last year we had illustrated their motor starters and their coil-winding machinery.* By a further development of these machines special paper insulation can be put between the wire layers of high-tension coils, the wedge formation which we noticed last year being retained to ensure high dielectric strength. Coils conical in cross-section, for rail-track signalling and other purposes, are wound by other machines at high speed; the bore is parallel, the windings are deep at one end and taper down at the other end. For high-tension secondary windings in wireless work, a double conical coil has been developed. The first layer is of short length, and the subsequent layers first increase, and then decrease again in length, the object being to diminish the potential difference between the initial and final layers where the volt-surgings are most pronounced; the check insulation can also be increased at the spots where it is most wanted. To-day we will describe some control devices for heavy electric machinery and some other novelties of the firm.

The big-panel and push-button board with accessories, which we illustrate in Figs. 1 and 2, on page 275, have been installed for a boring mill of one of the largest shipbuilding and engineering firms on the Clyde, and similar equipments are used for various types of machine tools, gun-boring lathes, and the wheel lathes of large railway shops where wheels of all sizes have to be turned. Each boring mill is driven by a variable-speed direct-current motor, the speed range being 300 r.p.m. to 900 r.p.m. The control is entirely by push-buttons, and the two complete sets of control buttons provided for each mill, one on each side of the rotating table, enable the operator to attend to his duties without leaving his stand. Five of the buttons of a set are marked: Start, speed-up, slow down, stop, inch. When the start button is depressed, the motor accelerates up to its normal speed of 300 r.p.m. at a predetermined rate. To accelerate, the operator presses down the speed-up button, until the 900 r.p.m. are reached; the switch controlled by the button inserts resistance in the shunt field. When the speed is too high for the purpose, the slow-down button is pressed, and the field-regulating resistance is short-circuited; this goes on as long as the button is pressed, or until the normal speed has been restored. The stop button is a master-button, that is to say, it prevails if any other button should simultaneously be touched. When the motor is stopped, and the inch button is depressed, the motor circuit is closed, but none of the starting resistance is short-circuited, and the motor will consequently continue to run at low speed as long as the button is pressed.

More than two sets are supplied, for instance, for long lathes where each saddle is fitted with its own set of buttons. The "lock" and "free" buttons further marked in Fig. 2 prevent interference with the machinery when more than one operator is in charge. An operator wishing to go on presses the lock button; all the other controls, from his own or other stands, are then rendered inoperative, and remain so until he releases them again by pressing the free button. Under working conditions the free button is flush with the face of the box, while the lock button projects; in the reversed case, the free button would project. One of these buttons thus commands the other, and similarly the slow-down will prevail if the speed-up were simultaneously called for from another position. Whenever the motor circuit is opened, a dynamic brake automatically helps to effect stopping, within the shortest safe time.

Passing to the particular functions of the many instruments on the panel, Fig. 1, which fits into a case provided with a glass door, we see in the top row the armature-resistance contact makers and in the second row the interlocking contacts. There follows a big solenoid, a patented speciality of the firm, presently to be described; it occupies a central position in the third row of instruments, where it is placed between an overload relay fitted with a dash pot on the left, and an overload relay on the right; the two instruments in the fourth row, by the side of the lower part of the solenoid, are the main "clapper" switches, another novelty to which we shall revert. Underneath, in the fifth row, are the dynamic brake contacts, below them again overload relays, further isolating switches and finally, at the bottom of the panel, the cable lugs. The chief feature of the compensated solenoid is the cross-head contact maker which slides up and down, under the influence of the solenoid proper above and of gravity, between two rows of contact bars which project vertically from the panel; these bars are the contacts for the shunt regulator and the armature resistances. The cross-head keeps its position unless one of the speed buttons is depressed, to accelerate or to retard the machinery; the depression of the speed-up button strengthens the solenoid and makes it raise the cross-head; the slow-down button opens the solenoid circuit so that the cross-head falls by gravity; both these movements are damped by the dashpot. When the motor circuit is closed and neither of the two speed-varying buttons is manipulated, the solenoid has sufficient strength to prevent the cross-head from slipping down, but not enough to pull it up. The dynamic brake is under the control of the main clapper switch. The overload relay mentioned opens this switch when the load on the motor exceeds a predetermined limit. In case of failure of the supply voltage, the switch is likewise opened and the crosshead then automatically returns to the starting position. To some controllers an automatic device is added which reduces the motor speed when the tool encounters a hard spot, until the need of the extra effort is passed, when the normal speed is restored. In such cases the overload circuit breaker may be omitted, but this is not necessary, since some machines can maintain an overload for considerable periods even after the return to normal speed.

The chief feature of magnetic lock-out "clapper" switch of the Igranic Company (Fig. 3) is that two independent magnetic circuit coils are provided, the central big coil for operating the switch and the lower, boxed-in coil for effecting the lock-out. The usual form of series switch can start, stop and reverse a motor to satisfaction, but it cannot regulate the speed. For the latter purpose a series relay and a shunt-wound switch are required. When it is further desired to combine automatic lock-out with starting, that is to say, to hold the switch open as long as the current exceeds a certain predetermined value, and to close it

* See Engineering, August 30, 1918, page 235; September 6, 1918, page 247.

ELECTRIC MACHINERY CONTROL.

THE IGRANIC ELECTRIC COMPANY, ENGINEERS, LONDON.

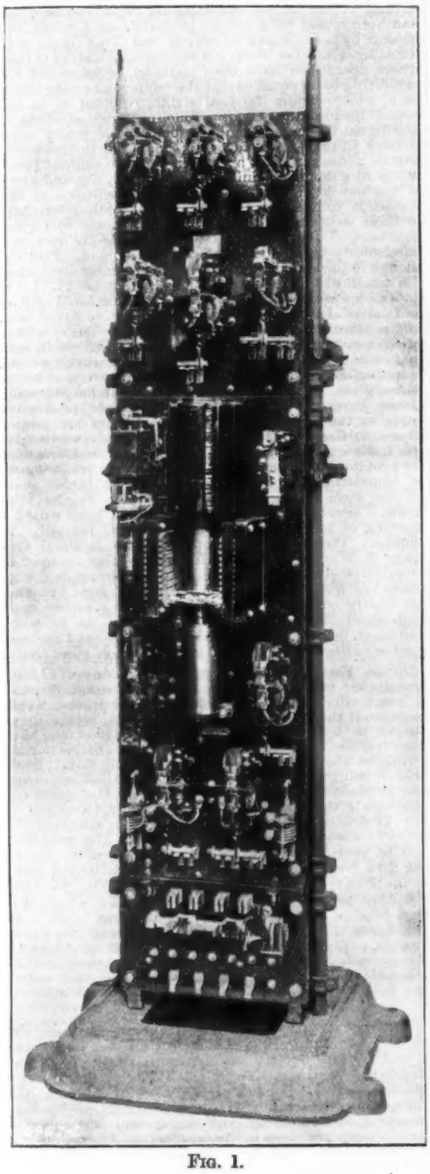


Fig. 1.

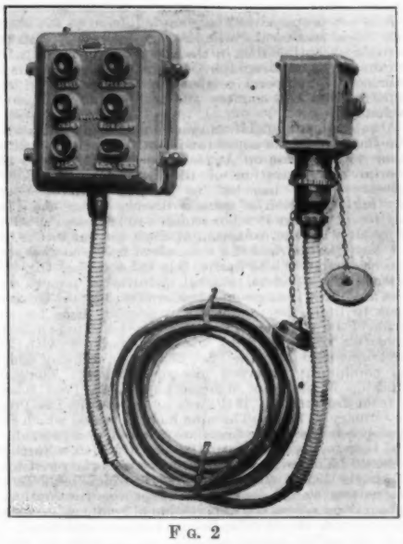


Fig. 2

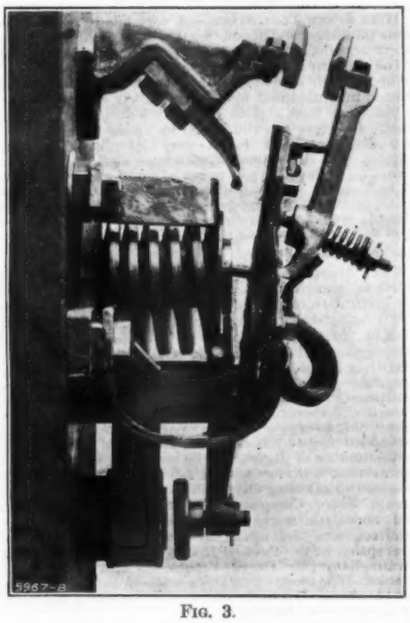


Fig. 3.

when the current in the operating coil falls to that value, one solenoid or coil can hardly suffice effectively to perform the two functions, to close at relatively low excitation and to prevent closing at high excitation. To combine the two functions alternating paths may be provided for the flux produced by one coil, and the excitation range may be adjusted with the aid of screws; but there is a limitation in the closing and sealing, and a certain tendency for the switch to tremble in the balance. The provision of two independent magnets, in series with one another and with the armature, so arranged that they act on different arms of the same armature bar, meets these difficulties. With a heavy rush of current through the two windings the lock-out coil holds the switch open until the current has fallen off to the predetermined value; the operating coil then prevails and pulls the armature into contact. The moment these contacts meet, the lock-out coil is short-circuited together with a certain portion of the starting resistance; that means a further rush of current which strengthens the operating coil and ensures the positive sealing of the switch. Trembling in the balance is thus avoided, and strong springs can be used on the contact fingers; these springs help afterwards quickly to open the switch, and give to these series switches the advantages of shunt-wound switches. The current limit at which the switch will close is adjusted with the aid of a plug mounted in the lower end of the switch arm by means of which the air gap between the lock-out coil and the lower arm can be varied. Each portion of this adjustable plug represents 2½ per cent. of the switch rating, so that the adjustment can be effected without the aid of an ammeter. The contacts are double, as our photograph, Fig. 3, shows; there are, in addition to a copper leaf brush pressing against a copper plate for the main contact, renewable arcing tips of copper which protect the main contacts; both the sets are fixed vertically to keep the dust off. In the multiple clapper rheostat of the firm a number of these switches serve for cutting out the armature resistance. The rate of acceleration is, in these simpler panels, governed by the load on the motor, which starts up quickly under a light load. The advantages of the almost automatic control of the heavy machinery of rolling and boring mills are not limited to ease and simplicity and to the general merits of electric power transmission. It is quite an essential point that the operator should be free to concentrate his attention on his work, and not worried by the fear that he might be too late or otherwise unable to prevent a mishap. He knows that he has merely to attend to his buttons and cannot, for the moment, do more than that.

The simple-back electromotive-force starter of the firm for small, direct-current motors (up to 2 h.p.) consists of two clapper switches which will suffice for the distance-control of starting, inching and stopping. On closing the circuit somewhere, one of the two electromagnetic switches closes the motor circuit through a single-step resistance; the motor starts and runs up to half normal speed; then the second switch closes which is connected across the motor armature, and the starting resistance is cut out, while the motor is thrown across the mains. Fans, vacuum cleaners, buffing machines and similar motor-driven appliances are kept under ready control by these switches.

The devices we have so far noticed are designed for continuous-current systems. The self-acting switches for polyphase squirrel-cage motors are for use on circuits of 550 volts and less and up to 60 periods per second, such as are wanted for driving centrifugal pumps and similar machinery which will start under a torque smaller than their normal full-load torque and accelerate with a terminal voltage considerably below the line voltage. For machines demanding high starting torque the squirrel-cage motor is unsuitable. The Igranic starter may be either of the auto-transformer type or of the resistance type, the latter being suitable only for small powers. The transformer or resistance are mounted in the framework of the panel, which bears a time-element relay and clapper switches to cut out the resistance in the predetermined sequence. The starter will not operate unless all the resistance is in circuit and the motor cannot be thrown directly across the line. The rate at which the transformer windings or the resistance are cut out is governed by a dashpot fitted with an adjustable valve. The master switch, which may be a float, a push button, &c., closes the circuit of the operating coil of the time relay; this energises the clapper switches cutting out the resistances under the control of the dashpot. The transformer type is supplied as a single-step or a two-step starter, being provided with one or two intermediate transformer taps respectively; the single-step is used when the starting torque required corresponds to more than 40 per cent. of the line volts.

The panels for the automatic starting rheostats of slip-ring polyphase motors bear, in addition to the resistance, double-pole clapper switches both for the stator circuit and for the rotor circuit. When the operating switch is closed, the stator switch joins the stator to the lines. Current is induced in the rotor which has some resistance in series with the relay controlling the action of the first rotor clapper switch; the first current rush causes the relay to open an auxiliary path which is kept open by the relay, until the current has dropped off to a certain value, and then only allows the contacts of the first rotor switch to be made. The switch short-circuits a section of the resistance; another current rush follows, the second relay comes into action, and this cycle repeats until the whole of the resistance is cut out and the rotor short-circuited. As in the previous cases, the first step in the starting may be effected by any kind of switch, a push button, tappet switch, a float, a pressure contact, &c.

The Igranic unit type of battery charging equipment is designed for the very useful purpose of supplying garages with simple fool-proof appliances which enable untrained hands to charge up the batteries of electric cars without any risk of over-charging or mis-managing the resistances or making a wrong connection. Each unit is a small panel containing all the necessary apparatus; five or more units are fixed to the same iron framing to form a standard panel, and a new unit or a panel is added as the necessity arises. When the battery feeders have been connected to the main lugs, all the wiring is done. The unit, 24 in. by 10 in., comprises number-card holder, fuses, indicating lamp, rheostat, cut-out, meter-reading switch and a low-current switch; the resistance is mounted at the back of the slate panel. One ammeter serves for testing the volts and amperes of any unit of a panel. The cut-out has a laminated brush for the main contact and an auxiliary sparking contact, and is so interlocked with the regulating rheostat that it cannot be closed unless all the resistance is in the charging circuit. The cut-out further prevents the battery from discharging back into the circuit should the charging volts fall below the battery volts; when several batteries are being charged simultaneously, and the service fuse should be blown, the cut-out will open the circuit lest the cells should discharge into one another. This cut-out can itself be fitted with a tripping coil to be operated by a push button from the distance. The units will take charges up to 180 amperes. In group panels one unit differs from the others; it is used as a discharge section, and by the aid of a double-throw knife switch connections are made either for discharging or for charging the respective battery.

The unit principle has very neatly also been adapted to the design of the last patented novelty of the Igranic Electric Company which we mention, the lifting

magnets for the transport of iron masses in works. When iron rails are to be transported in a mill, the units are grouped in alignment so that a considerable length of the rail is under the direct magnetic pull; when scrap is to be lifted, a large magnetic area may be preferable, and to deal with iron masses of particular shapes other groupings of the units may offer advantages. For lifting billets magnets of rectangular shape would seem appropriate; otherwise the circular shape looks the most suitable. The circular magnet has other electric and magnetic advantages. A circle encloses a greater area per unit circumference than a square or polygon; as the watt losses in a coil increase with the length of coil, the circular coil is most economical. Further, a circular coil can be wound more easily, compactly and uniformly than a rectangular coil which will tend to bulge on the sides, and there is less movement and strain of the insulation in a compact coil than in a loosely-wound coil under the influence of the electromagnetic attraction between contiguous layers each time the coil is excited. On the other hand, the square shape has mechanical advantages. The coil is therefore made circular surrounding a central pole, but the iron case in which the coil is fixed is externally cubical and not cylindrical; for convenience the vertical edges of the case are bevelled off so that the magnet is finally octagonal rather than square. Internally the case is machined so as to reduce the clearance between the coil and iron surface to a minimum, and care has been taken to get a large number of ampere turns within the space of the case, without undue temperature rise. On the top of the case is the lug for the hook by means of which the magnet is suspended from a chain. Each unit of 20 in. by 20 in. is in itself complete, and one size suffices for many purposes. When increased pull is wanted, several units are bolted together in one or several rows or in groups as desired.

KEY INDUSTRIES.

With reference to the Prime Minister's statement in Parliament on Monday 18th inst. on the subject of trade policy, and dealt with in our leading article on page 247 *ante*, the Board of Trade make the following announcement as to the steps which are proposed in connection with imports of goods from abroad. Legislation will be introduced when Parliament reassembles in the autumn:—

(*a*) For the protection of goods manufactured in Great Britain and Ireland against dumping by taking power to prevent the sale in this country of similar goods beneath their price in the country of origin;

(*b*) To enable the Board of Trade to check any flood of imports (for instance, from Germany) that might arise from a collapse of exchange so disproportionate to costs of production in the country of origin as to enable sales to take place in this country at prices altogether below costs of production here.

(*c*) To deal with unstable "key" industries in the following way:—

A limited number of unstable "key" industries will be scheduled, the products of which will be prohibited from importation into this country except on licence. Pending legislation, a general licence under the Prohibition of Import Proclamations will be issued by the Board of Trade having effect as from September 1, 1919, and authorising the importation into the United Kingdom of all goods with the exception of those in the following list, which will be treated as unstable "key" industries:—

(1) All derivatives of coal tar generally known as intermediate products capable of being used or adopted for use as dyestuffs or of being modified or further manufactured into dyestuffs, all direct cotton colours, all union colours, all acid colours, all chrome and mordant colours, all alizarine colours, all basic colours, all sulphide colours all vat colours (including synthetic indigo), all oil, spirit and wax colours, all lake colours, and any other synthetic colours, dyes, stains, colour acids, colour lakes, leuco acids, leuco bases, whether in paste, powder, solution, or any other form.

(2) (i) Synthetic drugs (including antiseptics).

(ii) Synthetic perfumes and flavourings; synthetic photographic chemicals; synthetic tannins; esters and acid derivatives of aromatic hydro-carbons; alkaloids and their salts (except quinine); and the following organic chemicals:—Acetamide; acetic acid; acetic anhydride; acetyl chloride; camphor bromide; cinnamic acid and its salts; ethylene bromide; formamide; formic acid and its salts; gallic acid; lactic acid and its salts; nuclein; paraldehyde; pyrogallic acid; saccharine or other substances of like nature or use; salicin; thymol.

(iii) Analytical reagents; and the following fine chemicals:—Barium compounds; cerium fluoride and fluorides of other rare earth metals; hydrosulphites and allied bleaching compounds; hypophosphorus acids; iron and ammonium citrate; iron tartrate; molybdic acid and its salts; phosphorus oxides and halogen compounds; salts of per-acids and artificial peroxides; silver nucleinate and proteinate; tungstic acid and its salts.

(3) Optical glass, including lenses, prisms, and like optical devices. (4) Scientific glassware. (5) Illuminating glassware. (6) Laboratory porcelains. (7) Scientific and optical instruments. (8) Potassium compounds. (9) Tungsten powder and ferro-tungsten. (10) Zinc oxide. (11) Lithopone. (12) Thorium nitrate. (13) Gas mantles and mantle rings. (14) Magnetos. (15) Hosiery needles, latch. (16) Gauges.

In addition to the above, in pursuance of the undertaking given by the President of the Board of Agriculture in the House of Lords on March 19, 1919, the prohibition on the importation of hops will be continued for the present.

It is not proposed to make any addition to the above list, unless and until Parliament so determine, with the possible exception that in the event of the contingency foreshadowed in paragraph (*b*) above arising it might be necessary to suspend temporarily all or any of the imports from the country affected by the collapse of exchange.

A subsequent official announcement is as follows:—The Board of Trade understand that the notice issued by them to the Press on August 22 with reference to the interim administration of the Government's "key" industry policy has led to some misapprehension. Pending legislation a general licence under the Prohibition of Import Proclamations is to be issued to cover all goods with the exception of those set out in the list of "key" industries. In the case of kerosene and benzine (including White Spirit) Gas Oil and Fuel Oil, this general licence refers to total quantity of import and does not affect the agreement entered into by the Government to limit the number of importing firms for the period of the existence of the Pool Board, and nine months thereafter to those firms which co-operated with the Government to form the Pool Board as a result of which the community received material benefits. The termination of the war organisation of the Pool Board as from January 31, 1919, was announced in the Press on January 2, 1919. The nine months period which has to elapse before other firms are allowed to import does not, therefore, expire until October 31, 1919. Further, it should be noted that in accordance with the provisions of Article 295 of the Peace Treaty, which requires all the parties to the Treaty to adopt the International Opium Convention, the importation of opium and cocaine except under Home Office licence remains prohibited.

High-Speed Tool Steel.—A very handy booklet has been published by Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, Openshaw, Manchester, entitled "The Modern Development of High-Speed Tool Steel." It opens with a history of tool steel, gives the various brands manufactured by the firm, their general characteristics and uses, and reviews the scientific aspect of tool steel. It is carefully illustrated by views, micro-sections and diagrams, and forms very interesting reading. Figures of a large number of actual tests are given in detail. The booklet will prove of great service to users of high-speed cutting tools. Editions, written in two or three foreign languages and judiciously distributed abroad, would greatly help our foreign trade in tool steel and machine tools.

The Institution of Mining Engineers.—The thirtieth annual general meeting of the members of the Institution of Mining Engineers will be held this year at Birmingham, on Wednesday, September 10, at 11 a.m., in the Medical Theatre of the University of Birmingham. The members will be welcomed by Sir Oliver Lodge, principal of the university, and by the president of the South Staffordshire and Warwickshire Institute of Mining Engineers. The annual report of the council will then be read, and the names of officers for the ensuing session will be announced. Some alterations and additions to by-laws will be submitted for approval, and a number of papers will be read and discussed. In the evening a dinner will be held at the Grand Hotel, and, on the following day, excursions to the works of the Austin Motor Company, Limited, and to the cocoa and chocolate works of Messrs. Cadbury Brothers, Limited, have been arranged. Afterwards there will be a reception at the Council House by the Lord Mayor of Birmingham (Sir David Brooks, G.B.E.) and Lady Brooks. The meeting will terminate on Friday, September 12, after a visit to Stratford-on-Avon which has been arranged for on that day.

10,000-Mile "National" Benzole Test.—We have received the following from the Automobile Association and Motor Union: A standard 16-h.p. Sunbeam has been selected for the above test. The car is a new one, being a works demonstration car, in the original grey. A start will be made from London on Friday, August 29, and the following towns will be visited on the approximate dates shown: Leeds, August 29 and 30; Edinburgh, August 30 and 31; Inverness, August 31 and September 1; Glasgow, September 1 and 2; Harrogate, September 3; Darlington and Newcastle-on-Tyne, September 5; Manchester and Liverpool, September 6; Birmingham, September 8; Newport, Cardiff and Gloucester, September 9; Northampton, Bedford and Newmarket, September 10; Norwich, Peterborough and Coventry, September 11; Newport and Chester, September 12; Oxford and Salisbury, September 13; Brighton and Chichester, September 15; Basingstoke, Guildford and Tunbridge Wells, September 16; Exeter, September 17. These dates are tentative, and further announcements will be made later. In addition to the test car mentioned above, another Sunbeam car will be used as a tender. At the suggestion of the Institute of Automobile Engineers, Captain E. Arter has been appointed as independent observer, and the engine will be examined both before and after the test by Captain Arter and the Engineering Department of the Automobile Association. Captain R. H. Montgomery, the head of the Fuel Department, the Automobile Association, will also accompany the test car as observer.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Iron and Steel.—The resumption of manufacture in the South Yorkshire iron and steel industries is proving a more gradual process than was generally anticipated. Several of the largest steel-making departments which had been closed for a month, re-opened on Monday, but work is by no means in full swing, and is not likely to be for at least another week. A satisfactory feature is that, where operations have been resumed, workers are not exhibiting to an equal extent the tendency to take things easy, which, before the coal strike, resulted in an all-round decline in output. This changed attitude is attributed to the economic lessons of five weeks' compulsory idling. Manufacturers hope the improvement will be permanent, but are not inclined to commit themselves to a definite opinion. Industrially, the undertone is not too assuring. Prices of all descriptions of raw materials continue high, with no immediate prospect of their declining; indications rather point to further increases. Complaints of the scarcity of pig-iron, and particularly of foundry iron, are widespread. Further, though inquiries from export buyers are freely circulated, the amount of new business booked is not heavy. Local quotations for large descriptions of manufactured articles and material are anything from 10 per cent. to 30 per cent. higher than those of foreign competitors. Many of the prices quoted for engineering work are based on an estimation of further advances in material and working costs. Manufacturers prefer to quote on current terms and to embody in contract agreements an indemnification clause covering the possibility of higher productive costs at the time of delivery, but buyers are largely averse to the practice. Axles and tyres are wanted for the Indian railways, and tramway points and crossings for provincial corporations. Arrangements are in course of completion for Sheffield to supply a larger share of the steel in locomotive construction in the Midlands. Messrs. Cammell Laird and Co. have called a meeting of shareholders for Friday next, formally to sanction their amalgamation with the Midland Carriage & Wagon Company, Limited. The output of crucible steel more than meets current demands. Furnaces are working short time. All the lighter branches are busily employed. America is buying rather more high-speed steel, which is quoted 1*s.* 6*d.* to 2*s.* a lb., delivered, below the American figure. Greece and Switzerland are ordering commercial steel and tools more freely.

South Yorkshire Coal Trade.—The tonnage of any description of fuel available for open market disposal is practically nil. Local industries and inland works require all the steam coal they can obtain, especially as output at those pits where full working conditions have been restored is 10 per cent. to 15 per cent. below normal owing to the institution of a seven-hour day. Some trade is being done with France and other Allied countries, but shipments, as a whole, are small. Manufacturing concerns in the Don Valley, who are solely dependent on the Yorkshire supply, are compelled to maintain the strictest economy in fuel consumption. The estimated loss in coal production throughout the county during the five weeks' stoppage is close on 4,000,000 tons. Quotations: Best branch handpicked, 33*s.* to 34*s.*; Barnsley best silkstone, 33*s.* to 33*s.* 6*d.*; Derbyshire best brights, 31*s.* to 32*s.* 1*d.*; Derbyshire house coal, 28*s.* 6*d.* to 29*s.*; Derbyshire best large nuts, 28*s.* 6*d.* to 29*s.* 6*d.*; Derbyshire small nuts, 27*s.* 6*d.* to 28*s.* 6*d.*; Yorkshire hards, 28*s.* 6*d.* to 29*s.* 6*d.*; Derbyshire hards, 28*s.* 6*d.* to 29*s.* 6*d.*; best slacks, 24*s.* to 25*s.* 6*d.*; nutty, 23*s.* to 24*s.*; smalls, 19*s.* to 20*s.*

University of Bristol.—A prospectus of the Faculty of Engineering, which is provided and maintained by the Society of Merchant Venturers in the Merchant Venturers' Technical College, Bristol, has just reached us. Courses of study are available at the College for persons intended to engage in civil, mechanical, electrical, or automobile engineering, and particulars of these courses are given in the prospectus. The ordinances and regulations relating to degrees and certificates in engineering subjects are included, and some particulars of the Bristol "sandwich" system of training engineers are also given. The prospectus can be obtained from the Registrar of the University, Tyndall's Park, Bristol.

Why Rails in Use do not Rust.—Under the title, "Why Busy Rails do not Rust," Oliver P. Watts has contributed a paper to the American Electrochemical Society (Transactions, vol. xxxiii., pages 173 to 181), in which he reviews the observations made since 1843. When the main track and the sidings are made of the same rails, the side tracks soon rust, whilst the main rails keep bright. At the British Association meeting of 1843, Robert Mallet referred to a report by George Stephenson drawing attention to that fact, and Mallet described his own observations and experiments. Believing galvanic action to be chiefly responsible for the protection of the rails in regular use, Watts conducted galvanic measurements showing the railhead to be positive with respect to the rail body. That strained, cold-worked iron turns positive has repeatedly been shown. But Watts did not experiment on rails *in situ*; he cut off portions of rails and vibrated some of them, keeping others quiet. If galvanic action were the main cause, however, we should expect the busy rail to rust rather than the idle rail. Watts also considers that the traffic removes any rust formed which would otherwise accelerate the rusting. The latter suggestion seems to be the more important; any oxide produced attracts moisture and carbon dioxide and favours further rusting; the traffic keeps the rail head clean, hard and bright, and the hammering of the rail by the train and the oil spattered on the rails assist in preventing the rusting.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—The condition of affairs in the Scotch steel trade shows little in the way of variation at the present time, and makers' books ensure steady running of the plate mills, at any rate for some considerable time. The activity in the shipbuilding yards is such that there is a constant pressing demand for ship plates, and with the output going steadily into consumption little is available for export even at higher rates than are being secured from the home buyers. The number of specifications for sectional material shows no improvement and only a moderate business is passing. Makers of black steel sheets keep fairly busy on orders booked recently, but owing to the last advance fresh buying is not very heavy. Inquiry for galvanised sheets is improving. In most departments there is some reticence as regards contracting for forward lots, both on the part of the buyers and sellers, and immediate requirements largely constitute the present dealing. Export business continues on the small side, but some fairly good inquiries have lately been received. No change has been made in prices, which remain firm, and although there are rumours of still higher values being fixed for next month, nothing definite is so far known.

Malleable Iron Trade.—The malleable iron makers in the West of Scotland are well fixed up with orders at the moment and active conditions are general. The amount of work on hand will keep the mills busily employed for a bit, and although buyers are not placing many heavy contracts the flow of fresh business is satisfactory. What is doing is almost wholly on home account and shipping lots are few. The price of "crown" bars is firm and unchanged at 21*l.* 12*s.* 6*d.* per ton, net, Glasgow.

Scotch Pig-Iron Trade.—Active conditions continue in the Scotch pig-iron trade and a very heavy demand is general, with some increase falling to be recorded in the amount of new business. Prices had gone so high that certain buyers delayed fixing up contracts in the hope of a probable decline, but the market maintaining its firmness they have now had to join in the scramble to secure their necessities. Hematite iron is in great demand by steel makers, and there seems to be no satisfying them owing to the urgency of the call for plates from the shipbuilders. Forge iron is quiet as there is little demand, but dealings in foundry iron are very good. The bulk of the trade is still on home account and almost nothing is being done in export. Prices all round are very firm and show no change.

General Trade.—Taken all round the conditions ruling in the steel and iron, and allied trades are very satisfactory, but the cry of reduced output is very general, and this must be remedied if we are to maintain our position in the world of commerce. Already we have felt the severity of competition from America, but that is not the only source from which we may be troubled as makers on the continent have been slowly but surely getting their works in order. Recently both French and Belgian material of different kinds has been on offer to consumers in this area, and as the home producers cannot promise near date delivery certain lines are being picked up.

Shipbuilding.—The orders just received from the Admiralty to slow down work on war vessels as much as possible were not unexpected. With regard to vessels under construction on the Clyde, operations will probably be stopped on about half a dozen, but others which are nearing completion will be pushed ahead so that room may be made for mercantile vessels which are so badly needed. It is not expected that much unemployment will result from the slowing down order, but there is bound to be a certain amount which will only be of a temporary nature until yards are prepared for mercantile work.

PROPOSED TUNNEL IN JAPAN.—According to *Railway and Locomotive Engineering* it has been decided to cut a submarine tunnel under the Shemonoseki Straight. At present, the railway systems in Honshu and Kyushu are connected by ferry boat. The total length of the new link would be 7 miles, of which 1 mile would be completely under the sea. The project would give a through railway connection between Tokyo and Kagoshima.

INDUSTRIAL PROGRESS.—The important work which is undertaken by the National Alliance of Employers and Employed in harmonising the relations between Capital and Labour is making rapid headway. Over 35,000 industrial firms and 2,500,000 workers have attended the one hundred industrial conferences which have now been held. Joint Area Committees have now been established in Birmingham, Cardiff, Great Yarmouth, Hull, Liverpool, Manchester, Mansfield, Newark-on-Trent, Nottingham, North London, Oxford, Oxfordshire, Plymouth, Peterborough, Reading, Runcorn, St. Helens, Sheffield, Walsall, Warrington, Wellingborough, Widnes, Wolverhampton, Worcester. Other committees are in process of formation in Brierley Hill, Dudley, Exeter, Glasgow, Grantham, Keighley, Newport (Mon.), Preston, Swansea and Wigan. A meeting with trades union representatives is to be held in Birmingham on August 30, while meetings will be held in Runcorn, Mansfield, Stoke-on-Trent and Winchester during September. Further conferences during October and November are to be held in various agricultural centres, and in Bolton, Kidderminster, Bury, Cambridge, Dewsbury, Hereford, Leeds, Leicester, Lincoln, Northampton, Oldham, Rugby, Stafford, Stourbridge, Bedford and Luton.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—The market is steady, firm and fairly active. Last week's race holidays at pig-iron consuming works, whilst blast furnaces were kept in operation, have relieved the position somewhat, but the scarcity of Cleveland foundry pig-iron, though certainly not quite so pronounced as it has been, is still great, so much so that export licences are once more granted very sparingly. Regular home customers are taking up most of the supply, but expansion of foreign trade is confidently looked for. Inquiries from districts at home, for which supplies are usually drawn from other areas, are meeting with no success. Such inquiries are due to the present relative cheapness of Cleveland iron, prices here having been stationary for some considerable time, whilst producers in other areas have put up quotations to cover increased cost of fuel. Forge iron continues so plentiful as to be something of a drug on the market, but purchasing of this quality is reported on a slightly larger scale. For home consumption, No. 3 g.m.b. and No. 4 foundry are 160*s.*; No. 1 is 164*s.*; and No. 4 forge, 157*s.*; whilst for shipment abroad, 5*s.* above these rates rules.

Hematite Iron.—East Coast hematite is in rather good request on home account, but inquiries from abroad are not very extensive. Makers are generally well booked, but are ready enough to make forward contracts. Mixed Nos. are 200*s.* for home use, and 205*s.* for despatch to foreign ports; and No. 1 is 202*s.* 6*d.* for home use and 207*s.* 6*d.* for export.

Foreign Ore.—Business in foreign ore is on a very small scale, consumers still holding off the market, as they have rather large stocks, and very substantial supplies coming steadily forward in fulfilment of running contracts. This week a cargo of over 10,000 tons—one of the largest cargoes which has entered the Tees—is being discharged at the North Eastern Docks. Rubio, of 50 per cent. quality is 53*s.* 6*d.* ex-ship Tees, and the freight Bilbao-Middlesbrough, stands at 25*s.*

Coke.—The great scarcity of coke is causing considerable anxiety. Very heavy local requirements are taxing sources of supply, and, indeed, essential needs are not met without difficulty, and demand for export is very pressing. Medium blast-furnace kind is 48*s.* at the ovens, and low phosphorus sort is 49*s.* 6*d.* at the ovens. For shipment, patent oven coke is 85*s.*; and beehive description, 90*s.* f.o.b.

Manufactured Iron and Steel.—Little new is ascertainable concerning finished iron and steel. During last week's holidays, much needed extensive repairs were carried out, the effect of which should be reflected in increased production. Manufacturers are heavily pressed for railway requisites, and shipbuilding material. To home customers, common iron bars are 22*l.*; marked bars, 24*l.* 10*s.*; strip iron, 22*l.* 5*s.*; steel ship, bridge, and tank plates, 18*l.* 5*s.*; steel angles, 17*l.* 15*s.*; steel joists, 17*l.* 10*s.*; steel hoops, 23*l.*; heavy sections of steel rails, 16*l.* 10*s.*; black sheets, 24 gauge, 23*l.* to 23*l.* 10*s.*; and galvanised sheets, 24 gauge, 28*l.* 10*s.*

INDUSTRIAL EXHIBITION AT BARCELONA.—An industrial exhibition is being organised at Barcelona to be held in January, 1920. It will be divided into four groups, covering (1) steel and wooden office furniture, office fittings, card indexes, &c.; (2) typewriters, calculators, dictaphones, telephones and other office machinery; (3) account books, loose leaf books, &c.; and (4) Industrial and commercial advertisements, luminous signs, posters and similar material.

TEMPERATURE REGULATION OF ELECTRIC FURNACES.—By making the heating coil of an electric furnace one arm of a Wheatstone bridge, Walter P. White and Leason H. Adams, of the Geophysical Laboratory, Washington, have succeeded in keeping the temperature of a laboratory electric furnace constant for hours within 0·1 deg. at temperatures between 500 deg. and 1,400 deg. C., practically without any attendance. They had formerly obtained a regulation within 5 deg. by letting a thermocouple-recorder make electric contacts which actuated a polarised relay controlling the heating current through the intermediation of a large magnet. But they desired to obtain a much more delicate control, and they then found that adjustments were required almost every second. They hence adopted the arrangement above mentioned, which is described in the *Physical Review* of July last. The energy of the regulation is taken from the heating coil itself, a platinum coil, and the energy available for regulation is hence very great; the regulator is practically a resistance thermometer with currents of 18 amperes; the average current is 14 amperes. There is no lag between heater and regulator, since the two are identical, and no need for introducing further appliances with the heater cavity. The disadvantage of the arrangement is that the temperature of the furnace is influenced by the room temperature and may thus vary slightly even when the coil temperature is kept constant. The current-regulating switches are moving in accord with changes in the position of the galvanometer boom. The movement can be effected by means of a device (small motor) pressing the boom down at intervals so as to strike or to miss a contact-maker controlling a relay. As the regulation depends upon the variation of the coil resistance with temperature, the arrangement is not well adapted for nichrome coils which have a very small temperature coefficient. It is further noteworthy that the arrangement, at least in the form described, is restricted to continuous-current heating.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Markets.—Coal is still being released very sparingly for foreign destinations, and new business remains difficult with prices firm on the basis of 85*s.* for good class large coals, irrespective of quality, 70*s.* for best small steams, 65*s.* for ordinary cargo smalls and from 45*s.* for inferior smalls. Prices are entirely dependent on the ability of sellers to give delivery rather than to the relative quality of coals. Lately business has been further disorganised by the official steps taken to secure tonnage for the home coasting ports. A number of small steamers previously fixed for voyages abroad have been refused their cargoes and directed to proceed coastwise. Congestion at the local docks is still heavy and many vessels are waiting for cargoes. There are over 400 vessels in Cardiff, Penarth, Barry and Newport despite the fact that lately many have sailed in ballast rather than wait for cargoes of coal to be released.

Newport.—Available supplies of Monmouthshire coals are insufficinet to meet the demand. The majority of collieries are fully booked over the next fortnight and are so comfortably placed as regards shipping that they are refusing to enter into new commitments. Buyers wherever practicable are holding off, but those obliged to go on the market have to pay high prices. Large coals of all descriptions readily command 85*s.* and smalls are worth from 55*s.* to 70*s.*, according to quality.

Official Absenteeism Returns.—Some interesting statistics have just been issued by the secretary of the South Wales Coal Owners Association in regard to absenteeism in the South Wales coalfields. According to these in the twelve months ending July 5, 256,326 tons of coal was lost through avoidable absenteeism and strikes, the former accounting for 4,594,457 tons of the total, 600,000 tons was lost through want of tonnage and 580,000 tons through men being unable to attend owing to accidents, falls, flooding, breakdowns, &c. The figures of avoidable absenteeism are important in view of the allegations of the miner's leaders that the reduction in coal outputs is due to causes beyond the control of the workmen. Further, another official statement gives concrete cases in which outputs have been deliberately restricted since the coming into operation of the Seven Hours Act. For instance, at one colliery the workmen reduced the filling of trams from 7 to 5 per day, and in another pit the owners after investigation were satisfied that the men were restricting outputs by about 18 per cent.

Miners and Income Tax.—A delegate conference of South Wales miners yesterday rejected a recommendation of the Executive Council which deprecated sectional action in the demand for the abatement of 250*l.* in the income-tax, and voted in favour of a previous conference resolution that no income-tax be paid until the abatement is raised to 250*l.*

Bunker Coal for Coasting Steamers.—The South Wales Coalowners Association have agreed to charge fixed prices for bunker coals for British vessels engaged in the United Kingdom trade. This arrangement has been made in view of the fact that freight rates in the coasting trade are limited, whereas there is no restraint in regard to coal prices. An early official announcement on the subject is expected.

OPENING OF ATHENS EXHIBITION.—His Majesty King Alexander of Greece has consented to open the Exhibition of British Manufactures organised by the Federation of British Industries in Athens. The exact date that will fit in with His Majesty's engagements is not yet known, but it is expected that it will be Sunday, October 19. This will be the public "gala" opening, but the exhibits will be arranged and the exhibition open to trade visitors on the date already fixed—October 13 (October 1 O.S.). Apart from business the exhibition promises to be the great social event of the Athens season. Nothing approaching the exhibition in importance and size has ever been held in Greece, and its novelty, together with the high patronage it is receiving, will make it the daily meeting place of Greek society. This will have its due effect on the business side of the exhibition and will add greatly to the opportunities of exhibitors for making acquaintances and friendships valuable in the future.

TIPPED TOOLS.—A compound for welding high-speed steel tips on to mild steel shanks for making up lathe and other machine tools, has been introduced under the name of "Fluxio" by the Fluxio Welding Company, Limited, of 5, Rawcliffe-street, Blackpool. Given a satisfactory tip-welding system the advantage of tipped tools in cutting down the quantity of high-speed steel which is required in making up tools, is obvious, and tipped tools have been used in large quantities for a number of years. In many cases the tips have been secured to the mild steel shanks by brazing. With the "Fluxio" welding compound no grinding of the seat on the shank is necessary, nor grinding of the bottom of the tip, nor does the tip require to be wired on. The shank as it comes from the hammer is covered on the tip seat with a layer of the compound about 1/4 in. thick, and the tip is placed in position over it. The assembled tool is then placed in a furnace and brought up to 1,350 deg. C. It is then placed on an anvil and the tip is given a blow with a 7-lb. hammer, the tool being then put in an air-blast to cool. When cool it is at once ready for grinding and use and does not require hardening. In addition to the compound, the Fluxio Company also manufacture tipped tools of various forms on their system.

THE WORKS OF MESSRS. BARR AND STROUD, LIMITED, ANNIESLAND, GLASGOW.

(*For Description, see Page* 263.)

FIG. 18. THE EXPERIMENTAL DEPARTMENT MACHINE SHOP.

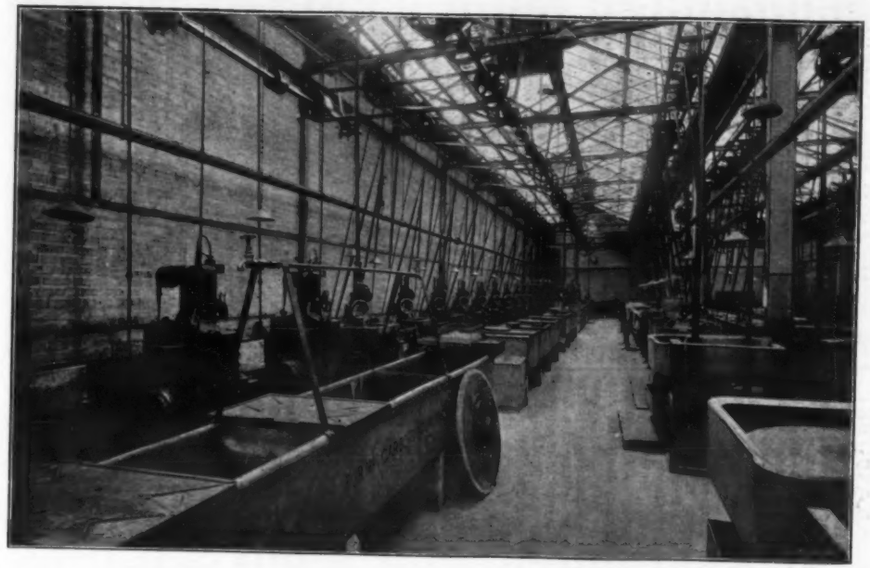


FIG. 19. PRISM-GRINDING DEPARTMENT: WEST WORKS.

FIG. 20. LENS SMOOTHING SHOP: WEST WORKS.

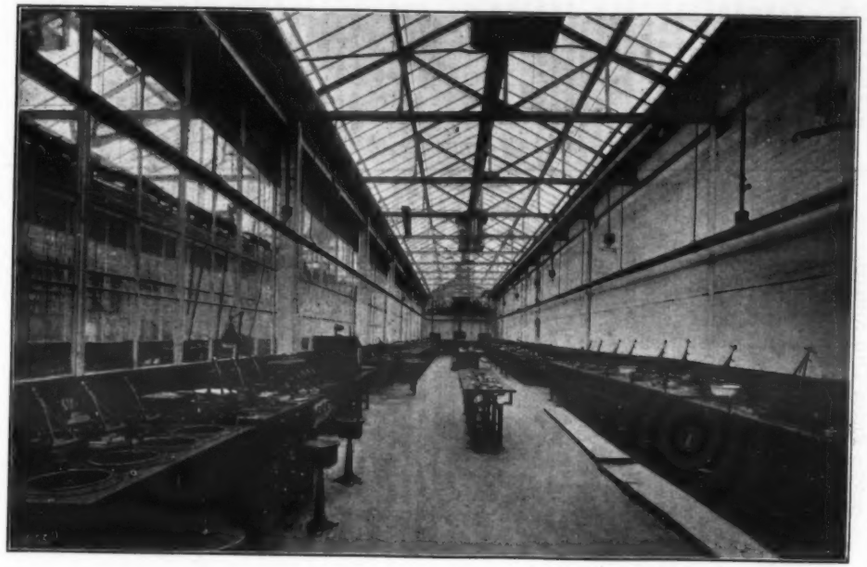


FIG. 21. POLISHING SHOP: WEST WORKS.

THE WORKS OF MESSRS. BARR AND S UD,

(For Descri Page 26

Fig. 12. Main Machine Shop; No. 4 Bay and Tool Room.

Fig. 13. Main Machine Shop; Centre Bay looking North.

S[illegible]UD, LIMITED, ANNIESLAND, GLASGOW.

(Descri[illegible] Page 263.)

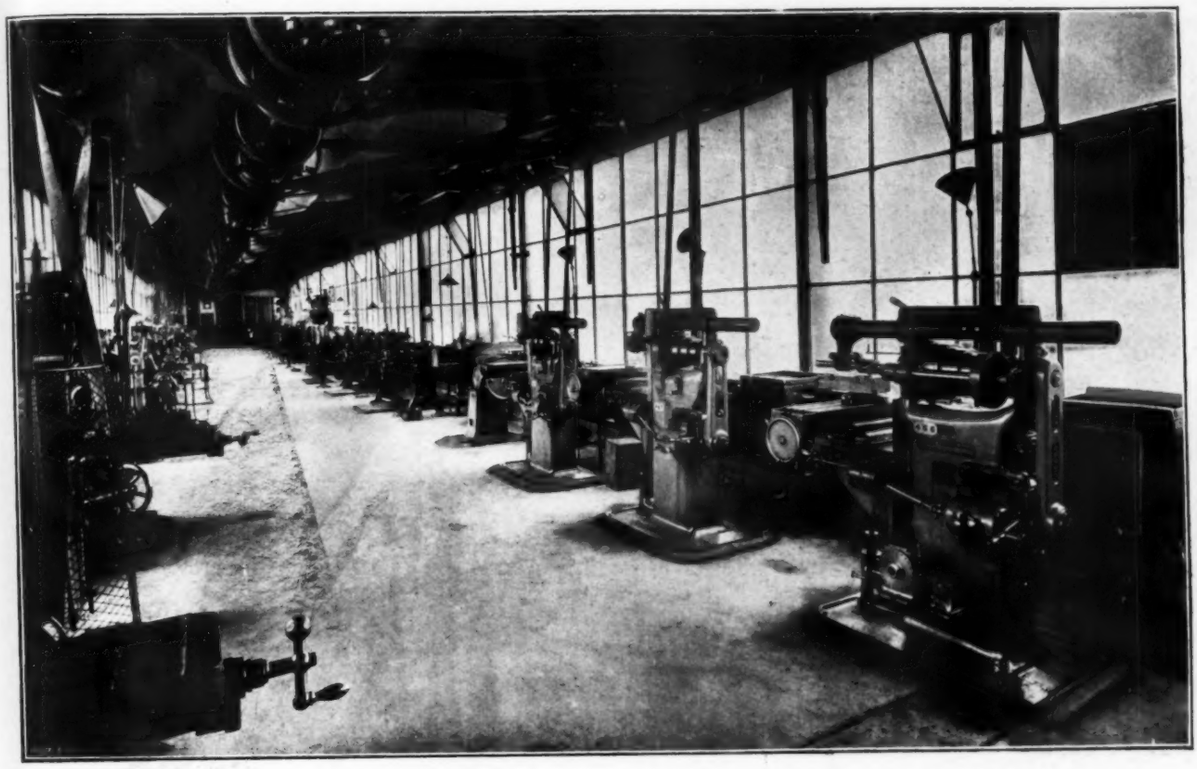


FIG. 14. THE EXPERIMENTAL DEPARTMENT MACHINE SHOP.

FIG. 15. THE GEAR-CUTTING SHOP.

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Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication, and certainly not later than Monday morning.

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We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

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With a Two-Page Plate of the WORKS OF MESSRS. BARR AND STROUD, LIMITED, ANNIESLAND, GLASGOW.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions still imposed by the Government on the importation of paper and the consequent shortage of supplies, Newsagents will not have copies for chance customers: therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

ENGINEERING.

FRIDAY, AUGUST 29, 1919.

COAL ECONOMY IN METALLURGY.

WHEN coal was plentiful and cheap there was little thought paid to the efficient use of the supply or the conserving of our resources. Now that coal is becoming scarcer and correspondingly dearer in Britain the law of necessity has awakened in us the knowledge of our previous extravagance and has filled us with the desire to cut down the coal expense by the more efficient application of what we use. In the iron and steel industries a large quantity of coal is used each year and, unfortunately, much is used unnecessarily, so that there is presented a large field for the application of the latest principles of fuel economy. Taking the output of steel at 9,500,000 tons per annum, the amount of coal consumed will be between 40,000,000 tons and 50,000,000 tons at the present time, and although the possible saving in coal which might be effected may not seem large, the real importance of the saving will be reflected in the price of the steel, as every shilling per ton in the price of coal means 4*s.* to 5*s.* on the price of steel. It may not be out of place, therefore, briefly to indicate where a saving can be made—where, in fact, it will require to be made in the near future—in the amount of coal used for metallurgical needs.

In the production of coke for the blast furnaces the replacement of non-recovery coking ovens begun during the war must be completed, for there is still roughly 20 per cent. of our present output which is coked without recovery of the by-products. The surplus coke-oven gas is already being used for heating purposes at the present time in British works, and represents a considerable economy in coal.

In the blast furnaces the average consumption of coke per ton of pig-iron is roughly from 1 ton to 1·2 tons, with a consumption of ore which varies between about 2·3 tons to 2·5 tons. These figures compare quite favourably with American practice, which runs from 0·9 ton to 1 ton and about 2 tons of ore per ton of pig-iron, taking into account the poorer quality of the ore used in Britain. There can be little hope, then, for any substantial general reduction in this case, though something may be done by bringing the average practice up to the level of the best.

In the conversion of the liquid pig-iron into steel the ideal method is to use the metal direct in the open-hearth furnaces or through a mixer, while the open-hearth furnaces, reheating furnaces, boilers, &c., are heated by the surplus gases from the coke ovens and blast furnaces. No further fuel is needed to make the finished article, and the amount of coal used is only that necessary to make the coke required by the blast furnace which works out about 2 tons per ton of pig-iron. In rapid-working basic furnaces a yield of 100 per cent. can be maintained, so that per ton of finished steel the amount of coal required need not exceed a total of 2·25 tons per ton. Possibly half the coal which is consumed to produce steel at the present time could be saved, and although this is an ideal figure based on the production of steel in very large self-contained units, it is an ideal towards which all British manufacturers and metallurgists should strive and towards which they will be forced to move by international competition. That our steelmakers are already alive to the means by which economies can be effected is shown by the large combinations of allied interests which have taken place during the past few months, and among the economies which will result not the least important will be the economy in coal.

Such methods, however, are not generally applicable, but in the other systems of steel manufacture there are economies to be effected which, though small in themselves, do represent collectively a large amount. The boilers for driving auxiliaries, mill engines, &c., are seldom tested to find what efficiency they are running at, but it is unlikely that the average efficiency is greater than that of colliery boilers whose efficiency was put in a recent article in this journal (ENGINEERING, July 25, page 101) at 55·5 per cent., against a possible 70 per cent. The steam auxiliaries driving the live rolls, pumps, shears, &c., are so apt to be overlooked if they do not require attention for repairs, that their steam consumption may be 10 or 12 times the equivalent consumption of power if electric motors were substituted.

Many heating furnaces are notoriously wasteful and are responsible for a large coal consumption. Melting furnaces, although they are the most important type, have never been thoroughly studied from the efficiency point of view, and there is an almost complete dearth of figures giving the heat balance of an open-hearth furnace. At the last autumn meeting of the Iron and Steel Institute, Sir Robert Hadfield, to whose initiative the metallurgical world owes so much, suggested that the question of sound steel and fuel economy in open-hearth practice should be examined by a special committee, and the matter was referred for consideration to the council, but so far no tangible results have developed, although the suggestion was well worthy of the greatest energy and enthusiasm. This is a question which should be taken up by an association of manufacturers for the benefit of the industry as a whole.

With good producer practice the consumption of coal with cold charging varies from 8 cwt. to 10 cwt. per ton of steel ingots produced, but even 12 cwt. is by no means uncommon, partly due to careless practice and slow working, so that there is room for a much smaller average consumption than exists at present. There are many details about open-hearth furnace design which could be standardised for maximum efficiency and made to replace the diversity of design which adds to the first cost and also to the cost of repairs, and which would help towards further fuel economy.

Although in steel works it is often advisable to sacrifice a little economy for simplicity in design and in working, in the majority of mill-heating furnaces the simplicity has been achieved with far too great a sacrifice of useful heating, and they are extravagant in the extreme. As an instance of what may be done in the way of securing better results, we may mention that in an article on "Coal and Industry," published in *The Observer* of July 13 last, Sir Robert Hadfield stated that by gradually introducing improvements and putting down reheating furnaces of an economical type his firm had reduced the consumption of coal from 15 cwt. to 2 cwt. per ton of steel reheated. The erection of waste-heat boilers helps to recover a little more from the fuel, but this plan, although successful in some works, is not so widely adopted yet as it will be, while it does not get away from the fact that the design of many existing furnaces is bad and should not be perpetuated.

In heat-treatment plants of moderate size it was often cheaper during the war to use coal-gas than any other type of fuel, because coal-gas furnaces were so efficiently designed that the extra costliness of the fuel was more than balanced by the better use made of the heat supplied. Steel works engineers will be forced now to develop more scientific designs for their furnaces, or to more extensively adopt good designs already available, for the saving is not only represented in coal, but also in diminished scaling and waste of steel during heating.

In America the use of pulverised coal is rapidly extending until now more than 12,000,000 tons of coal are pulverised each year, the reason given being that more efficient results can be obtained from this fuel than by any other system of fuel burning, and that the cost of the plant is far outweighed by the saving attained. In steel-making, for instance, a ton of steel can be produced with from 4 cwt. to 5 cwt. of pulverised coal, and with a lower labour cost per ton of coal handled. The claims which have been made will no doubt get the serious attention of British engineers, and it is almost safe to predict

that this method of heating will be extensively adopted in the near future. The recent improvements in the method were the subject of an interesting paper before the Iron and Steel Institute at their last meeting (Engineering, July 11, page 62). Figures given in this paper show that in some actual recorded cases the saving in a great variety of types of heating furnaces for annealing, heating, puddling, and forging was in every case considerable and often resulted in an increased output as well. Although with open-hearth furnaces the difficulty introduced by the presence of the ash in the fuel has not yet been completely overcome, it is not a difficulty which is likely to prevent the ultimate adoption of the system.

In the comparatively unexploited field of fuel economy the metallurgical industries have a prominent though not perhaps enviable position, and the solutions of the problems which lie before them will lead, we hope, not only to better economic results for themselves, but also to a purer atmosphere for us all.

PROMOTION FROM THE RANKS.

It was the saying of a very famous soldier—a saying perhaps now worn bare by repetition—that every private in his army carried a field marshal's baton in his knapsack, and in military connections it is remarkable how many famous soldiers have enlisted in the ranks. It has always been recognised that ability was by no means the special prerogative of any special class, social or otherwise; it cannot be controverted that in any connection where the candidates were confined to a select minority, prejudice and stagnation ruled. War, by reason of the imperative need for real leadership and outstanding ability, the cost of defeat being so enormous, has invariably been the grave of peace-time military reputations, this in spite of the fact that its training was largely confined to the affluent save in inferior grades.

Unlike the older professions, one outstanding feature of engineering has been its democratic spirit, it has afforded scope and real expectation of advancement to the lowliest possessed of the requisite ability; mechanical sense is in some respects a natural gift more than a matter of academic training. This prospect has favoured its development, for its recruits have been drawn from all classes, and success has by no means been confined to the more expensively trained, in fact, the vast strides unparalleled elsewhere may in great part be considered as due to the democratic spirit evident throughout the world of mechanism.

The tendency to-day to stress academic qualifications at the expense of those whose school has been the bench, whose diploma is practical ability, and whose knowledge consists more in experience than mathematical exposition of first principles has elements of danger all too apparent upon reflection. If it is impossible to achieve any real elevation save by the rung of academic distinction, the ambitious but poor candidate will shun the business, and the industry so closed will suffer as other professions have suffered, and in time its development be restricted. Most men like to think they have at least a sporting chance of considerable advancement, and to restrict or bar all avenues of approach to position and responsibility inhibits intelligence lower down, there are few indifferent to opportunity, and even if only one here and there achieves place, it leavens the rest. If there is no outlet there will be no candidates, what is worse below a given level apathy will rule.

In contradiction to the heretical views here expressed, will be quoted the fact that educational facilities are now more extensive and opportunities more general than formerly, yet this even does not affect the argument very greatly; until all opportunities are really equal, social position does confer the very real benefit of superior training and so give their possessor a start the advantage of which is undeniable. The point is, that if this start be made an absolute essential, then no amount of hard work or loyal service—to say nothing of capacity—can equalise the higher level at the beginning.

It is curious, but many capable mechanical minds are by no means apt scholars from an examination viewpoint, They are objective rather than reflective, they may miss over the symbol but are alive to the reality; it may even be asserted with some show of reason that mechanical aptitude is in inverse ratio to capacity for book knowledge, hence the difficulties experienced in teaching students whose mentality and bent is of directly engineering type this more especially where abstract theory is in question. No man has greater need of mathematics than an engineer, yet they have to be literally forced into the majority or what is tantamount to the same thing, specially digested or simplified for their benefit; the same applies to composition, there are few who display ability in this direction. This all points to the same end, an outstanding mentality for mechanical things may fail to win academic approval, and so under conditions where selection is on the grounds indicated may be refused admission though otherwise capable. Such refusal is not in the best interests of the industry, service and proven merit should be allowed to count in substitution.

On the one hand, industry is to be democratised, yet insistence is increasingly laid upon pure academic distinction as if this in itself were of supreme importance. Further than this the concern which invariably imports the outsider to its higher posts, will find a lack at lower levels, the incentive to effort below becoming paralysed.

Intrigue, influence and social position apart, some effort should be made to discover and promote the competent, for it is too little realised that responsibility is apt to make the man, and position alone gives pretty rapid education in the vital things which count. The element of luck is just as potent in the case of the stranger within the gates, when he is foisted on the disappointed, too often he does not come up to expectation, and the existing staff from whom otherwise selection would have been made, supplement his deficiencies and find the conditions galling. The domestic candidate has a known record, and in all probability legitimate aspirations, and the installation of a complete stranger is a reflection not merely on those who have expectations, but upon the organisation of the concern. Such a policy saps loyalty, unless ability of specialist or peculiar type is in question, some one man has outstanding characteristics which earmark him for the post. Over and over again small salary, onerous conditions, sheer hard work have been suffered only because of a remote sporting chance on the far horizon, and to make it patent that chance will never be afforded, is to give reign to slackness and poor service. It is the man buoyed with expectation who will put real effort into what he believes is a preparatory task, not the man to whom the future presents a hopeless blank.

The man reared on the ground has loyalty, and if promoted by easy stages is likely to prove an asset; it must always be remembered that discipline is as much a system of reward as the infliction of penalty for infringement of regulation; the most potent scheme yet devised in the interests of efficiency, is promotion from the ranks by merit. It is a specific form of payment by results, warranted to have an instantaneous reaction upon effort. In the army of industry, as in more military connections, outstanding ability is found at all levels, and promotion from the ranks has received its own justification too often to require special examples to illustrate its value; it is just possible that under modern ideas the need for its due consideration may escape notice.

CONFERENCE OF RESEARCH ORGANISATION.

In 1915, a scheme for the organisation and development of scientific and industrial research was sanctioned by Parliament, who, unguided by precedent, probably knew little of the machinery necessary for success. The scheme approved involved the formation of a Committee of the Privy Council, to which was attached an Advisory Council, wisely composed of men eminent in pure science with others equally prominent in the world of industry. Following on the original construction, many industrial associations of manufacturers have been formed under the auspices of the Council, and their co-operation has been both hearty and helpful. By their widespread influence the objects and the possibilities of research have become more widely known and better understood. The cry for scientific research had been loud and persistent, but the few who saw the necessity for endowment and the practical advantages attaching to trained and organised research, were as voices crying in the wilderness. For public opinion looks for guidance from authority, and until practical measures were inaugurated by the Government, a lack of support and a want of singleness of purpose beset the steps and crippled the efforts of the pioneers on this toilsome road. Now the cry for research is in the mouths of all; not only do the enterprising and the active see a prospect for enlarged effort and new adventure, but the dissatisfied and the indolent hope for a happy issue out of all their troubles. As a consequence of the initial movement, various rival scientific research associations have been set up whose functions are as comprehensive as they are difficult of realisation. These associations are all sincerely animated by the laudable object of advancing the interests of pure and applied science, and ameliorating the conditions of national life. The eagerness to start these competing associations suggests that the Government scheme has not met with such general approval as was anticipated. Complete concurrence in one scheme was not to be expected, but these separate associations may lessen the authority and divert the attention which should be centred on the main institution. The concentrated energy necessary for success may easily be frittered away by too wide a distribution over many interests, and intelligent guidance lose its efficiency by divided counsels.

At a time therefore when public attention is aroused, but not satisfied, and when immature proposals find a ready hearing, those responsible for the Government scheme are well advised to call together the members of many industrial councils to deliberate on the problems that invite criticism or may be misrepresented from interested motives; to consider practical difficulties that arise from actual experience; and to consult on the opportunities that offer for extended usefulness. Apparently such was the object of the meeting held at the Board of Education Offices on the 29th ult. under the presidency of Sir W. McCormick, Chairman of the Advisory Council, when the representatives of a large number of trade research associations met the members of the Council for Scientific and Industrial Research. The meeting was deliberative and not executive. The object was to elicit opinion not to issue instructions, and if few conclusions were reached, the Council were informed of the reasoned convictions of those directly concerned in the conduct as in the success of the scheme. Further, as necessity arises future meetings will be called, so that close contact and mutual understanding between the executive and the workers is assured.

The list of firms and research associations present at the meeting is too long for quotation, but some 30 were represented, and the majority by more than one member. The Italian Embassy and the Belgian Minister both sent delegates, while in addition to the Chairman and Secretary (Sir Frank Heath, K.C.B.), Professor J. A. McClelland, Sir Maurice Fitzmaurice, Sir George T. Beilby, and the Hon. Sir Chas. A. Parsons attended as members of the Advisory Council. The activity of the Board is, however, greater than is indicated by the list, for the chairman stated that already nine research associations were in being, eight more approved by the Department were only awaiting the licence of the Board of Trade, while the admission of 12 others was still a matter of discussion between the several industries and the Board. Four topics engaged the attention of the meetings: (1) The formation of a Records Bureau; (2) The Conditions of Employment of Research Workers by Research Associations; (3) Co-operation amongst Research Associations for the Study of Accessory Materials or Equipment; and lastly, Subscriptions to Research Associations.

The object of a Records Bureau, as gathered from the speech of Mr. Fleming, of the British Westinghouse Company, is to collect and circulate all the available knowledge about any special industry, but he intimated that it might not be expedient or feasible in the present rudimentary condition of

industrial research to initiate such a scheme on international lines. He generally approved the suggestion of the Department to limit their responsibility, and to undertake only what can be economically handled and made thoroughly trustworthy. He urged, however, that activity should not be limited to circulating the bare records of the Research Associations, but that an effort should be made to preserve the incidental, but often valuable, matter that resulted as a by-product from a research investigation, too often lost for the want of some agency to give permanence to this fleeting matter. Mr. Fleming also called attention to the danger of giving too exclusive attention to the accumulation of masses of indirect or incidental features of information. Doubtless the collection of such material from foreign research organisations, or from obscure sources, generally inaccessible to the public, was eminently desirable, "but there is a grave risk in launching out and forming a central bureau, extending to work of this kind, of making it instead of a live intelligence department, really a dead museum." Attention was further urged on the desirability of linking up all who were engaged in the work of research. Isolation and the absence of corporate life were inevitable, and therefore the advantages of personal inspiration and encouragement from fellow-workers were difficult or impossible. Contact and intercourse were to be encouraged by every means, with the view of removing the evils of secrecy and its hampering influence on research work. Under the menace of war many restrictive shackles disappeared, and under the common menace now threatening industry, secrecy should be reduced to a minimum. For a long time to come it is to be expected that research will be conducted more and more along lines of solving problems incidental to improved processes and methods, promoting greater efficiency generally, and the research knowledge bearing on such questions is in the minds of men and not in books. Hence the Department should assist in promoting intimate contact among research workers. Further, the importance of educative influence could not be overlooked, for not only are employers and labour concerned in these questions, but the consumer is also to be considered. All share alike in the responsibility of encouraging research, and this responsibility is increased by the growing tendency for State aid and State control to interfere with industry.

Major Bliss (Woollen Research Association) urged the need of founding more and better technical libraries in provincial centres. In the absence of such facilities he suggested that arrangements should be made for the proposed Bureau to transmit copies of, or extracts from, papers on application from research workers. Mr. Heathcote (British Non-Ferrous Metals Research) from a slightly different point of view supported the suggestion.

Mr. Beck (Scientific Instrument Makers) desired some restriction to be placed on indiscriminate publication. Members of the associations were generally under the impression that the results of the researches promoted were, in the first instance, the property of the Association initiating the enquiry, hence it was desirable that the position of individual research associations with regard to work which they had originated should be clearly defined. Admitting that many cases would arise in which different trades had a common interest, communications would be essential to prevent overlapping of work; it was therefore of the utmost importance to know what steps the Department proposed to take in order to safeguard the interests of the associations who were already disclosing many facts with the view of benefiting the trade concerned. The danger of information deposited with the Bureau reaching the hands of competing companies of different nationalities was not to be overlooked. As a corollary to this remark Mr. Marlow (Boot and Shoe Research) commented on the unwillingness of the Americans to supply valuable intelligence. Information was usually withheld till it was two or three years old, and he suggested that the Records Bureau might be usefully employed in quickening the interchange of ideas and information. Mr. Williamson, colleague of Mr. Beck, expressed anxiety lest the funds at the command of the Department should be absorbed in the formation of a Bureau to the detriment of the immediate purposes of experiment and enquiry.

Sir Frank Heath, Secretary of the Department of Scientific and Industrial Research, returned sympathetic and reassuring replies. It was declared again categorically, that the ownership in scientific results remained in the hands of the members of the Association; each association holds that property in trust for its members. Secrecy where necessary could be secured and guaranteed by dividing the Bureau into a confidential and non-confidential section. Communications could be sent to either section, but, if sent to the former, the Department would use strict precautions to ensure privacy. Information from the Bureau would be forwarded to others only with the knowledge and consent of the party depositing the information. But somtimes this confidential matter might be of great value to another Research Association, and in that case the Bureau would be prepared to play the part of "honest broker," and negotiate the transference of that information on agreed terms. On the question of finance, Sir F. Heath gave equally satisfactory replies. The Council were keenly alive to the danger of devoting their energies to the collection of the dead dry bones of science, and whatever services the Bureau could render they were to be regarded as additional, and would entail no burden on the "million fund" earmarked for research. The Department had an annual vote in Parliament as well as the "million fund" and efforts would be made to persuade the Treasury to allow fresh funds to be voted for the purposes of the Bureau. With regard to access to libraries and the dissemination of literature, it was pointed out that it was the primary duty of a research association to have its own library and records bureau. The central authority would not relieve the associations from getting their own information. To undertake such a task would lead to the collection of dead material at the centre entirely out of touch with the actual processes of industry. At all times the Central Bureau would be ready to assist in distributing matter difficult of access, but it would be unwise to undertake an agency for sending out extracts of papers on all and sundry subjects. The central authority would help and act as a kind of clearing house and co-ordinating authority.

Some further doubts having been expressed of the wisdom, or the opposite, of sending to the Bureau confidential information that it was not intended to publish, Sir Herbert Jackson, F.R.S., supported the proposal for collection on the ground that it was desirable to set up some body to act as a kind of trustee of progress and activity on the subject of research. Such a body would keep a watchful eye on the whole amount of national research and, being in possession of this confidential information, would be competent to spur on others who are not doing what ought to be done, and would survey the whole field. This department holding these pieces of information, even after a very limited experience, would be admirably placed to recommend what should be circulated.

The second item for discussion affecting the conditions of employment of research workers has been the subject of much hostile comment and has occasioned some soreness. Section 14 on the conditions under which grants are made to students has generally been condemned, and the lines upon which it has been drawn found little favour at the meeting. Alderman Hinchcliffe (Chairman of the Woollen and Worsted Research Association) insisted that the success of the various endeavours in the different fields of research would depend very largely on the generosity and fair-mindedness with which the agreements with research workers were treated. Unless these agreements were absolutely fair as between the association and the workers the scheme was doomed to failure and would certainly fail to raise the standard of life of the community or succeed in alleviating many of the bad conditions that have hitherto prevailed. The first item of the agreement should be that the investigator be paid such a salary as to relieve him of all family anxiety, otherwise his mental effort is depreciated and he cannot give the best service to the work. With the view of attracting the most acute brains the Woollen and Worsted Industries had sent a notice to the factory of every subscriber to the effect that the Research Association, being desirous of encouraging discoveries or inventions in the textile trades, are prepared to assist financially and by expert advice the promotion of any such discovery or invention. If the confidence of workmen is to be invited and their intelligence enlisted, careful and generous consideration must dictate the agreement.

Sir F. Heath read a letter from the director of an engineering research laboratory that focussed much of the criticism directed against the original suggestion. "One general criticism of this pamphlet is that it regards the research worker merely as an individual and not as a member of a team." One paragraph has in it: "The germs of a disastrous failure." "The payment to people of special amounts on account of successful work creates the worst spirit on a research staff. Firstly, a successful result is hardly ever the work of a single man. It nearly always arises as the result of conversations with, and suggestions from, others. One has known cases where the research man has received all the essence of an idea from a workman, and one can recall few cases in which much help has not come from colleagues. The bestowal of special grants is liable to cause ill-feeling and tends to invite secrecy and exclusiveness. Secondly, the director is responsible for assessing pieces of work to different individuals, and it puts him in an unfair position when he has to give a man a piece of work, which in the nature of things cannot lead to anything for which a special grant could be obtained. I suggest that general individual merit should be rewarded by salary increases, and that successful research work should be rewarded by a grant to be divided amongst all members of the research staff whether they have participated in the successful research or not." After some remarks on the position and responsibilities of the director, the writer proceeds on the vexed question of publication. "Whilst it may be undesirable to publish some things the majority of the work done in a laboratory can be published, and every encouragement should be given to prepare papers for publication. When it is undesirable to publish the results of research, there is usually no difficulty in giving an account of the research." Finally the writer insists that it is untrue to say that "the ultimate aim of industrial research is mainly financial profit." "The main object of industrial research is to build up a strong and progressive industry."

Very general agreement with the tenour of this letter was expressed. Mr. Greenwood (Cotton Research Association) remarking as the result of his experience that where a man is working for a bonus as against a salary, he often lost that real interest in his firm and in his industry that he ought to have; he became self-centred in the idea of how his efforts might affect the reward he receives. Sir George Beilby, F.R.S. (Director of Fuel Research), also expressed general approval, pointing out that it is a very difficult and dangerous practice to begin apportioning the special share of credit to each member of a research staff to be followed by a money payment. His own practice had always been to give all the able men who were doing their best to improve the manufacture in which they were concerned an interest in the whole of the profits. The men then felt that their work was recognised, that they were taking their part and that that part was acknowledged. Special prizes or special bonuses tended to make men narrow-minded, and nothing was thought of but to make that particular department successful, and to show how much was saved. Sir Herbert Jackson, F.R.S. (Scientific Instrument Research), said that he viewed with consternation the proposal to give a research worker any kind of bonus. On any research work being done, it was better for all concerned to meet and discuss it, so that each mind might bring its little bit of knowledge to the sum total. Such mutual assistance would have to stop instantly; "the only way is to remember, that when you get a good man you should pay him well, and when you have got your good man, give him a feeling of security of tenure by increasing his salary."

In the original Section 14, the bestowal of a grant is made subject to the condition that "the

Committee of Council reserve the right to determine whether . . . the Committee shall secure to themselves by patent, designs, or otherwise, the ownership of the results of the research and any benefits and profits arising therefrom." In some quarters this clause has been regarded as obnoxious, and the Secretary invited an expression of opinion upon the difficulties that might arise, if a worker wished the result of his work to be patented and the Association declined to give permission. Should the inventor have the right to patent his invention at his own cost, and take any benefits that might accrue ?

Colonel O'Gorman (British Aircraft Constructors) related his experience in trying to prepare some form of agreement which might be accepted, both by engineers and by the employing firms; and admitted the difficulty of the position outlined by the Secretary. He did not think that firms attempted to touch the inventions of their workpeople; as a rule the workman came in without agreement and was free to protect what he pleased against the firm, or to sell it to outside people, or to transfer himself and his invention to new people who were prepared to exploit him. Higher skilled men were generally bound by agreement to assign their devices and inventions to the firm, leaving it to the generosity of the firm to make a reward. This he regarded as a perfectly good arrangement, but it did not meet the case of the aggrieved worker who was prevented from patenting on his own behalf. He did not think that the individual inventor should be rewarded *ad hoc* for his invention, when he was a whole-time employee of a firm. That expression of opinion met with general approval. "I have found," concluded Colonel O'Gorman, "that the proof of good organisation is team work, and the death of team work is individual pulling against one another, working up secrets and then crystallising them into a patent, in order to put it before the management in the hope of getting a money reward."

Mr. Dixon (Manufacturers' Research) gave, as a possible solution, the description of a plan occasionally followed in some firms, where all employees had a right to patent their own ideas on the condition that the employers had a free use of the patent for all time. The share of the employer was a free use of the inventions of all the employees, but that the patent part was the property of the patentee.

The Hon. Sir Chas. Parsons claimed that a man is quite at liberty to patent things done in his own time, which he was not employed upon and which have no connection with his employer's business, but has no right to apply for a patent for anything in connection with the employer's business. Alderman Hinchcliffe considered that a financial inducement was necessary to prevail on a workman to give of his best, and in addition it might be necessary to provide scientific advice. On the other hand Mr. Prentice (Diesel Oil Engine Users) contended that the true inventor does not carry out his researches for a money reward. This Research Association need not give him a pecuniary remuneration for his work, but they should encourage him to proceed with his schemes, especially if the attainment of success is long deferred, and no doubt they would pay him something, but the monetary reward will not be the sole object at which he aims.

The Chairman admitted the interest of the discussion, but foresaw that an absolute solution was not possible that day.

Colonel O'Gorman introduced the third subject on the agenda paper, the desirability of co-operation amongst Research Associations for the study of accessory materials or equipment. He compared co-operation with the quarry material used to build up the greater edifice in which all research associations take part. All are members of a township in which there are various buildings and houses, and in this town the value of each house is enormously enhanced by its proximity with the others, and by the facility thus afforded for intercommunication between the persons in these buildings and their ability to use, in common, certain public services. Co-operation is directed in industrial organisations to securing industrial advantages, and these advantages may be obtained by what is apparently a gratuitous sharing with others of the good things collected by our own efforts. The research associations are concerned with the study of materials and methods, some of which are found to be equally necessary to many of the neighbouring industries, and it is by sharing both knowledge and the expense of acquiring knowledge, that the increments of value derivable from living in the township are obtained. Where the industries do not compete with one another co-operation for the common end can more easily be initiated than where there is competition, and therefore it is precisely for the study of accessory materials, that one may hope more easily to get joint support, that is co-operation, for research. Colonel O'Gorman gave instances in which scientific progress in one branch of industry had proved to be profitable to many others quite disconnected. It would be difficult to adjust a nice balance of advantage where widely different interests are concerned, but if we concentrate on the one common improvement we need not enquire whether other interests clash or not, we merely establish that in this one relation they may join hands in the study of so-called "accessory material" and leave the other questions alone.

Sir Frank Heath remarked that the problem had been considered by the Council at the outset, but unguided by experience, they were feeling their way on *a priori* principles. He was inclined to favour the proposal, that joint committees should be appointed to include representatives of a number of associations, and that these joint committees should have specific problems referred to them, and that by agreement between the various associations contributions should be made to finance the associations. As an example a research association for refractories might be imagined, consisting mainly of manufacturers of refractory materials, but since refractories enter into a large number of industries, that association was not likely to be successful unless it was in close touch with the industries that use refractories. There must be many subjects, where several research associations were directly interested in some particular, which though it might not be the main product of the industry was yet of great importance to all. The proposal he had to make was, that committees *ad hoc* should be set up in order to learn whether this was the most successful way of proceeding.

Alderman Hinchcliffe referred, as an alternative, to a proposal which had found favour in the textile industries. He suggested that in the case of allied associations having a common interest, each should elect two or three members to serve on the associations of the others. The points of contact with the several combining associations would be easily recognised, and that association would be appointed to carry out the research that was best adapted for the purpose. Further discussion was reserved for future occasions.

The Chairman called upon Sir W. Jones (British Refractories) to introduce the fourth subject, "Subscription to Research Associations." Sir William pointed out that the success attending the formation of associations depended mainly on securing sufficient subscriptions from the industry immediately interested. From the experience he had found that the recommendations of the Department were open to grave objections. Seven schemes, or tests, had been suggested as a basis for determining the amount of subscriptions. These included (1) a levy on the total capital; (2) on the average annual profits; (3) on the annual wage bill; (4) on the number of employees; (5) on the volume of the output; (6) on the value of output; and (7) on the amount of plant. Obvious objections could be raised to each of these, but every one involved the disclosure of facts appertaining to the business of individual firms. In face of the general opposition encountered in his particular association the consent of the Department was solicited for permission to substitute a voluntary basis for a percentage levy. By approving a voluntary basis it would be possible, and legitimate, not only to approach the manufacturers who were interested in refractories, but also the consumers and all who would derive advantages from the establishment and work of the Research Association contemplated. It was equally easy to raise objections to the voluntary system, since it tended to encourage applications to firms outside the industry itself, and was liable to entail a duplication of applications for subscriptions, that might weaken the active interest which each firm in an individual industry ought to feel for its particular Research Association. But time and experience must correct anomalies and remove difficulties. The formation at the moment of a kind of super-association to be built up out of and on top of these Research Associations could not be approved.

Sir W. McCormick acknowledged the obstacles that the Refractories Research Committee had encountered, but did not think that they could be regarded as typical of the associations generally, or applied to the various systems on which contributions had been made.

Mr. Greenwood thought that in adopting the principle of voluntary subscriptions sufficient security of tenure was not assured to those who were employed in research work, to which Sir W. Jones replied that each subscription was accompanied by a guarantee for its continuance for five years.

Sir Frank Heath thought that variety of practice was of small importance, the more so, as probably voluntary assessment would cease, because the disadvantages of a system by which some associations raised their income by levy, and others on a voluntary basis, would become obvious. And again many firms in order to cover the whole of their activities would have to join more than one association, and confusion would follow the adoption of two different policies. He believed that eventually voluntary assessment would be based on some uniform procedure to be discovered by the Association itself. He did not think that any pecuniary difficulty would arise from lack of uniformity, and congratulated the Council on refusing to prescribe a uniform procedure.

The meeting concluded with the usual votes of thanks.

NOTES.

The Theory of the Carbon Gasification Process.

When carbon is gasified, by direct combustion on the grate or with the aid of steam in a gas producer, the reactions cannot be expressed by a single equation. In discussing the general problem with which the fuel engineer has to deal, Waldemar Ostwald (*Chemiker Zeitung*, April 29, 1919, pages 229-231) in fact distinguishes eight different reactions. He reduces them, however, to the following three fundamental thermochemical equations as essential and sufficient for most purposes: (1) $C + O_2 = CO_2 + 97{\cdot}6$ calories; (2) $C + 2H_2O = CO_2 + 2H_2 - 18{\cdot}8$ calories; (3) $C + CO_2 = 2\,CO - 38{\cdot}8$ cals. The other reactions which also come in question are: $2\,CO = CO_2 + C + 38{\cdot}8$ calories; $CO_2 + H_2O = CO + H_2O + 48{\cdot}2$ calories; $CO + H_2O = CO_2 + H_2 - 48{\cdot}2$ calories; $C + O = CO + 29{\cdot}4$ calories; $C + H_2O = CO + H_2 - 28{\cdot}8$ calories. Confining himself to the first three equations stated, however, and designating the relative proportions of carbon entering into the reaction (1), (2), (3) by a, b, c, he arrives at the equation for the complete process: $(a + b + c)\ C + a\ O_2 + 2b\ H_2O = (a + b - c)\ CO_2 + 2b\ H_2 + 2c\ CO + 97{\cdot}6a - 18{\cdot}8b - 38{\cdot}8c$. It will be noted that the formation of CH_4 is disregarded, and that no notice is taken of the nitrogen which acts as a diluent and does not essentially alter the conditions. The total amount of carbon would be $C = a + b + c$, and of these three quantities a, b, c only two are independent variables. The values of a, b, c, are determined by analyses of the products of combustion, and Ostwald represents his results by the triangular co-ordinates of Gibbs. If the base of this triangle be AB, the apex C, any point P representing the analytical results would fall within that triangle ABC, and any of the three sides is the sum of the three respective components a, b, c, which, with different processes of combustion, will have different lengths on the three sides. When P falls close to A or coincides with it, the dry combustion of carbon by air (without the interaction of steam) will be complete. When P falls near B, the combustion is all or nearly all due to the reaction with steam, air being excluded; when P falls near C, the reaction will consist of the reduction of CO_2

to CO or of the oxidation of C to CO, neither air nor steam taking any part. A point D on the side AC, half-way between the two corners, would represent the mixed-gas reaction of air gas and water gas, and a point E on the side BC, half-way between B and C, would mark the water gas reaction, the combustion of carbon to CO and hydrogen on the manufacture of water gas. The area of the whole triangle is divided into regions of combustion and gasification and of gas regeneration. Ostwald shows in his paper how isothermals and isocalories can be diagrammatically represented, and how the diagrams enable the chemist and engineer to determine thermochemical and volumetric characteristics of the combustion under any working conditions, the coal consumed, the heating value of the gas produced, &c. The relations are not simple, and the fundamental considerations are not novel, of course; but Ostwald's paper is probably the first attempt to deal graphically with the whole technical combustion problem. Waldemar Ostwald, we should add, is one of the sons of Wilhelm Ostwald, one of the founders of the electrolytic-dissociation theory.

Temperatures of Metallic Arc Electrodes.

The constancy of the temperature of the crater of carbon electrodes is generally explained by the assumption that the temperature observed represents the boiling point of the carbon, which should be independent of the heating current, just as the boiling point of water does not change with the size of the burner flame underneath the vessel. The observations on metallic arcs made by A. Hagenbach and K. Langbein ("Archives des Sciences Naturelles, Genève," 1919 pages 48 to 54) tend to support that assumption. Metallic arcs are notoriously unsteady, and Hagenbach and Langbein experienced considerable trouble with them, especially when measuring the temperatures of the cathodes. The method they used—photometer of König-Martens—is the same that O. Lummer applied in his recent researches on carbon arcs, and the softening or melting of carbons, and their carbon-crater temperature, 4,200 deg. C. absolute, agrees with Lummer and others. Anode and cathode temperatures were determined; in our comments, temperatures are understood to refer to the anode unless otherwise stated. With increasing current intensity, the brightness of the light, and hence, presumably, the temperature in some cases increased visibility until a certain current intensity was reached, above which the brightness and temperature remained steady. That was so with silver, copper, iron and nickel; a large range was found for silver, the smallest for nickel; with silver, constancy was not attained. In the case of copper a current of 2 amperes gave a temperature of 2,235 deg. C. absolute, which rose to 2,450 deg. when the current was raised to 10 amperes and did not change any further with current intensities up to 18 amperes. The tungsten arc proved practically constant at 4,150 deg. C. or 4,250 deg. C., for all current intensities. The temperatures of the cathode were, as with carbon, always lower; thus with copper the cathode temperature did not exceed 1,450 deg., remaining about 1,000 deg. below that of the anode; with iron, the anode yielded 2,485 deg. to 2,605 deg., whilst the cathode did not heat above 2,430 deg., with nickel the anode temperature varied, with the stated variations of the current intensity, between 2,430 and 2,450 deg., whilst the cathode maximum was 2,365 deg.; tungsten gave 4,250 deg. at the anode, and 3,000 deg. at the cathode. Aluminium, zinc and magnesium differed from the metals so far mentioned in giving the same temperatures at both the electrodes, 3,350 deg. to 3,450 deg. for aluminium, 2,350 deg. for zinc, and about 3,000 deg. for magnesium. These latter temperatures are unexpectedly high, and the plausible suggestion is made that the temperatures observed are not those of the boiling metals, but those of the oxides, which are much less volatile than the metals, and might, hence, be considerably superheated, and have also high melting points. The suggestion finds some support in special observations made in atmospheres of nitrogen, whilst the figures so far given all refer to arcs burning in air. In nitrogen the temperatures were all much lower, by as much as 1,000 deg. in the case of aluminium, but this applies only to the three metals Al, Zn, Mg. Of these, magnesium and zinc arcs may be called easily-oxidisable. Aluminium only covers itself with a surface film of oxide at ordinary temperature; at high temperatures aluminium has a very strong affinity for oxygen, as we know from the thermit process, and aluminium must in that sense be considered oxidisable. Iron is readily oxidisable as well, however, and yet the electrode temperatures of iron, nickel and copper were the same in nitrogen as in air. Thus there is reason for further research.

LITERATURE.

The Strowger Automatic Telephone Exchange. By R. Mordin, with folding Plates and Illustrations. London: E. and F. N. Spon, Limited, 1919. [Price 21s. net.]

This work is a monograph addressed to the specialist rather than a treatise designed to inform the general student and reader. The author enters minutely into the technics of a problem whose detailed investigation lies outside the range of general electric engineering. He looks for his audience among the telephone community who, familiar with the processes of telephonic communication in general use in this country, wish to become acquainted with the arrangements that have made automatic telephony such a success that it will eventually supplant the existing scheme. Mr. Mordin has wisely confined himself to the method and principles of one system, and even with this limitation the intricacy grows bewildering, for he is not content to supply an intelligent conception of the method, but traces out the work of every wire and connection with scrupulous care. To have attempted exhaustive treatment of the many schemes and possible improvements that ingenuity has devised or experience approved, would have led to weariness and confusion. The system described is that of Strowger, as adapted by the Automatic Telephone Manufacturing Company of Liverpool, who have supplied the mechanism at work in the experimental stations selected by the Post Office authorities.

The author is inclined to look with a lenient eye upon the comparative stagnation that has resulted from the slight encouragement given to the active development of telephonic communication in this country. That we have not emulated the keen appreciation shown in the United States for this process may not be a matter of surprise, because our population was not so scattered, and there was not the same pressing inducement for bridging separating distances, and perhaps the forceful impulse that would push industry to its limit was not present. But when other and smaller Continental nations outstrip us in the development of electrical energy, we do not find these reasons, or those offered by the author, sufficient to explain our laxity and indifference. We believe more immediate operating causes are to be found in an unwise dread of competitive methods, in the benumbing influence of vested interests, and the lethargy inseparable from bureaucratic control. In the particular instance of the telephone, progress was, no doubt, delayed by the knowledge that Government would absorb the scheme that private enterprise had built up, and those responsible for its extension had little incentive to improve the operation. The telephone system, as operated under Government auspices, presents a melancholy spectacle of backwardness, ineptitude, and pecuniary loss, demonstrating the superiority of individual effort over centralised authority. It occasions, therefore, no surprise that automatic telephony attracted little attention here, and provoked no extensive or critical examination, till long after the scheme had become commercially practicable in the United States and elsewhere, but it is to be regretted that as a consequence of this delay, its peculiar devices had to be dovetailed into a long-established system that had adhered to a network of manual exchanges. The adoption of the method, therefore, in its entirety will be slow, and will become first operative in those centres, not where it is most needed or where its introduction would be most beneficial, but where it is least inconvenient to make the change. For this reason, the provinces will be equipped with an efficient system before the Metropolis, for the most favourable conditions for automatic working are to be found in areas served by a central office, or by a few offices where the traffic is mainly local, because "the number of connections requiring manual service in exchanges other than the automatic are then at a minimum."

Mr. Mordin naturally takes a hopeful view of the benefits accruing both to the public as users and the Government as suppliers of an automatic system, and one gathers that this outlook is supported both by practical knowledge and actual experience in working. Without setting out the advantages in detail, as the author does, it may be said that if the more important are realised, both the subscribers and the central supply authority may be well satisfied. The former are promised completion of connection in not more than six seconds, and immediate advice if the called subscriber is engaged. Not living in one of the happy areas where automatic calling is in force, we have not been able to test the accuracy of this statement by actual experience, or to enjoy the blissful freedom from irritation this arrangement promises. But automatic telephony has long passed the experimental stage, and Mr. Mordin's diagrams are not necessary to convince us that such expedition is attainable, and might be enforced. If the supineness of a long-suffering public can be overcome, we may look hopefully forward to a time, when the needless wait at the telephone is eliminated from the list of our daily annoyances. The saving of time to individuals will be considerable and the number of messages put through in a given time greatly increased. With the general adoption of a rate per message there should be some relief to the Exchequer, and this source of revenue may be further increased by a reduction in the cost of operation. Apparently, it would be possible to economize in operators' wages, training expenses, and accommodation. But here one enters the realm of conjecture. By examination of the plans detailing the mechanism, one is able to trace definitely the scheme and to predict the result with certainty. We have no such confidence in the behaviour of the human element. Here caprice and waywardness rule, and few would probably care to pledge themselves that there would be any pecuniary saving under any of these heads. Similarly, it is pointed out that it may be possible to economize space by using smaller premises than are required for manual equipment, and some reduction of cost might be effected in line construction, but it would be unwise to entertain the hope of any restricted expenditure.

We have no intention of following Mr. Mordin into the minute details that are necessary for successful working. As we have said, he is writing for experts and while it would be difficult to make the mass of the public understand what mechanism is involved and what results are produced by simply lifting the receiver of a telephone, such descriptions would be a wearisome commonplace to the few. The end sought in any exchange is to put two subscribers into communication, and the whole difference between manual and automatic telephony consists in the method of switching. The distinction is simply one of means. The manual system requires human agency to connect subscribers' lines, the automatic accomplishes the same work by electrically-operated mechanism. In thought, the operation is a simple one, the working out of the details so as to secure efficiency of action, compactness, and economy of space and material, is a work of considerable time and ingenuity. It is no light task in large multiple office areas, of perhaps 10,000 lines, to put a subscriber's line in connection with any other, but add the complications of trunk calls to distant exchanges, of private box exchanges, of test and examination rooms, and the entanglement becomes more confounded. Under certain circumstances, it is necessary to have recourse to the manual switch board.

The principles on which mechanical selection is based are easily understood. We will imagine the subscribers at an exchange conveniently divided into batches of 100, and that it is possible to arrange that the removal of the receiver of any one subscriber's telephone can give a loop to the exchange, through impulse springs, transmitter, and receiver

connecting his line to a disengaged trunk, outgoing from the hundred to which his particular line is attached. The line switch responds to the loop only, and the exchange switches operate in unison with rapid disconnections in the loop. The subscriber, on turning his dial plate, will open the impulse spring as many times as he moves his indicator over consecutive numbers, making a corresponding number of disconnections. Thus, three disconnections, followed by seven, and then by one disconnection, will connect the calling line with subscriber 371. The line switch is not a number-finding switch, but one which discriminates between idle and engaged trunks, selecting the former to extend the line to the next switch. It must be understood that the trunk terminates in a selector, as it is called, in waiting to receive the disconnections effected by rotating the dial plate on the calling device. In response to the number of disconnections the first selector picks up an idle trunk out of ten, which may represent the thousands integer, or hundreds according to the number of subscribers, and extends the line to a second selector switch, decided again by the number of disconnections, selecting a further disengaged trunk and extending the lines over one of ten trunks to a connector switch operating with the hundred digits, and finally the number of tens and units are picked up; this connection is then complete and ordinary telephony can proceed, or an "engaged" signal returned as may be necessary.

Such a scheme would work if the necessary circuits and connections could be made operative, and Mr. Mordin undertakes to explain how the process is perfected in practice, under the Strowger system. He writes clearly and effectively, making his points well, and receives great assistance from his diagrams. These not only supplement the letterpress, but sometimes supersede it. From such examination as we have been able to give, only one weak spot has been manifested. For the success of the scheme it is necessary that only a small proportion of the subscribers, say ten per cent., will be simultaneously engaged in originating or answering calls. Such numerical estimate may be justified under normal conditions, but it seems possible for ingenious, or spiteful, subscribers to concoct an arrangement by collusion, whereby the whole combination would be temporarily dislocated. But such a possibility does not affect the merit of the design or the skill with which the author explains it. His book will remain the authoritative explanation of what may be regarded as the official method of automatic switching.

BOOKS RECEIVED.

"*Wake Up, England!*" By Granville C. Cuningham, M.Inst.C.E. London: P. S. King and Son, Limited. [Price 3s. 6d. net.]

Our Atlantic Attempt. By H. G. Hawker, M.B.E., A.F.C., and K. Mackenzie Grieve, Lieutenant-Commander, A.F.C., R.N. With a preface by Major-General J. E. B. Seely, C.B., C.M.G. London: Methuen and Co., Limited. [Price 3s. 6d. net.]

The British Fleet in the Great War. By Archibald Hurd. Second Edition. London: Constable and Co., Limited.

The Claims of Labour and Capital. By W. R. Cooper. With a prefatory note by the Right Hon. G. H. Roberts, M.P. London: Constable and Co., Limited. [Price 2s. 6d. net.]

The Library Press Universal Wages Calculator for any Working Week and any Rate of Pay. Designed and compiled by Charles E. Lewton. London: The Library Press, Limited. [Price 30s.]

The Premium Bonus System. By W. Rowan Thomson, Wh.Sch. Glasgow: McCorquodale and Co., Limited. [Price 10s. net, post free.]

Steel and its Heat Treatment. By Denison K. Bullens. Second Edition, thoroughly revised. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Limited. [Price 18s. 6d. net.]

Automobile and Aero Engines. A Handbook for Students, Draughtsmen and Designers. By René Devillers. With a preface by Ch. Faroux. Translated by Wm. John Walker, B.Sc., Assoc.M.Inst.C.E. London: E. and F. N. Spon, Limited; New York: Spon and Chamberlain. [Price 16s. net.]

The Universal Directory of Railway Officials, 1919. Compiled from official sources under the direction of S. R. Blundell. London: The Directory Publishing Company, Limited. [Price 20s.]

The Occlusion of Gases by Metals. A General Discussion held by the Faraday Society, November, 1918. London: Reprinted from the Transactions of the Faraday Society. [Price 8s. 6d.]

The Design of Factory and Industrial Buildings, with Chapters on Welfare Work and Industrial Research Departments. By Ernest G. W. Souster. London: Scott, Greenwood and Son. [Price 10s. 6d. net.]

THE LATE PROFESSOR A. G. VERNON HARCOURT, F.R.S.

In 1910 the Chemical Society of London gave a banquet to five of its oldest members, who had at some period been Presidents of the Society. Of these five only two remained with us up till the end of last week; Sir Henry Roscoe, Dr. Hugo Müller and Sir William Crookes have passed away within the last few years. Now Professor Augustus George Vernon Harcourt, of Oxford, has died on April 23, and only one of the five, and one of the oldest, we believe, survives, Professor William Odling, also of Oxford.

A. G. Vernon Harcourt, the son of an Admiral, and grandson of an Archbishop of York, was born in London on Christmas Eve, 1834, and thus attained the ripe age of 85 years. Educated at Cheam and Harrow he proceeded to Balliol College, Oxford, with a scholarship to study natural science. It is characteristic of those days and of the old universities that, early in the 'fifties, two cellars of Salvin's building in Balliol College were given up to the study of chemistry, and one of the ablest Oxford men was deputed by his college to read up the subject so as to be able to take charge of the instruction in chemistry. Smith went to August Wilhelm Hofmann's School of Chemistry in Oxford-street, London, in which Perkin and Crookes and many other English chemists received their first lessons in chemistry. The story is due to Harcourt; it almost sounds like an anticipation of the days of the Science and Art Department when teachers were a few lessons ahead of their pupils for whose instruction they drew Government grants, and it is significant also in another, often overlooked respect. One of the chief reasons that induced Sir William Perkin to give up the manufacture of dyes was that he fully recognised that the development of a dye industry required years of systematic research, and he could not find any assistants nor assistance for such work in this country. Harcourt was among the first pupils of Smith, and afterwards worked under Brodie who, likewise a Harrow and Balliol man, had studied under Bunsen at Heidelberg. As Brodie's assistant Harcourt, in 1858, still an undergraduate, went over to the chemical department in the new University Museum. Six years later, meanwhile a graduate, Harcourt became demonstrator and later professor of chemistry in Christ Church College, and there he remained. In his first years at Oxford his interests were as much those of the classical scholar as of the student of natural philosophy. He was, in fact, offered a classical tutorship at Christ Church, and his later translations from Latin and Greek testify to his never losing his taste for classical studies.

His early work was chiefly on oxidation, on the peroxides of the alkali metals and on the oxidation of organic radicles and on oxidation and reduction problems generally. Rate of chemical reaction was then a new study, and he contributed several papers to the Royal Society on the laws connecting the condition of a chemical change and its amount. These were not his first papers, which he had read before the Chemical Society in 1862 or sent to the *Chemical News*; but in these more advanced papers he collaborated with a mathematician, William Esson, of Merton College. The most important of these investigations were the reactions between hydrogen peroxide and hydroiodic acid, which he followed up so persistently that he was able to estimate the absolute zero of temperature from his rates of reaction. Though the reactions of hydrogen peroxide seem peculiar in some respects even now, those researches continued for many years helped a good deal in establishing what is now known as the laws of mass action. To the engineer Harcourt's name is best known in connection with his work on coal and coal-gas. The oxidation of graphite was one of his early problems. Together with Esson he investigated the estimation of the illuminating power of coal-gas. His recommendation of the pentane lamp as light unit dates from the 'seventies. Though the old-fashioned standard sperm candle was most unsatisfactory, and Harcourt was senior Metropolitan Gas Referee, the old sperm candle of the law of 1860 remained the legal standard for many years; but the 10-candle pentane lamp of Harcourt prevailed finally. About 1872 Harcourt also showed that the carbon disulphide of coal-gas can analytically be estimated by passing the gas over hot calcium hydroxide, when carbon dioxide and sulphuretted hydrogen are evolved; the technical problem of destroying the carbon disulphide in coal-gas was only solved a few years ago by Dr. C. Carpenter.

Harcourt was a very careful and skilful experimenter. As a teacher Harcourt was most popular, and the house he had built for himself at Oxford entertained many learned visitors and students. His last years he spent in his beautiful house at St. Clare, near Ryde, which faces Spithead. He joined the Chemical Society in 1859, and was president of the society in 1895 to 1897. The address which he delivered in 1897 was brief and aimed at showing that the changes substances undergo when boiling, freezing, when being dissolved, when passing into allotropic modifications and when decomposing and dissociating, were all changes of the same kind and merely indicated changes of one kind of molecules into another kind. He was possibly right in insisting that there was little reason for saying that potassium chlorate "decomposed" into chlorine and oxygen, whilst phosphorus pentachloride "dissociated" into trichloride and chlorine, because, in the latter case, the bodies recombined on cooling, whilst they did not recombine in the former instance; but the distinction certainly has some justification, and the arguments were not carried to any depth. Harcourt was believed to assail the theory of ionic dissociation, which had no friends in Oxford then, in his address; he did not directly refer to the theory, however. He served on several British Association Committees, and was president of the Chemical Section in 1875 and afterwards one of the Honorary Secretaries of the Association; the connection had a family character, for an uncle of his, the Rev. W. Vernon Harcourt, originally a naval man, was one of the founders of the British Association. Before the Manchester meeting of 1916 Harcourt described how he arranged his drawing-room fire-place so as to keep the fire continuously burning practically without attendance. Professor Harcourt was elected a Fellow of the Royal Society in 1868, and held honorary degrees from his own university—in addition to his M.A. degree—and from the Universities of Montreal and Durham. He married, in 1872, Miss Rachel Mary, daughter of Mr. H. A. Bruce, later the first Lord Aberdare.

COASTWISE TRADE.

In consequence of the withdrawal of coastwise steamers a large volume of traffic has been diverted from sea to rail with the result that the railways are now burdened with traffic which they have not previously carried. The absence of normal coastwise shipping facilities is impeding the transport of the food supplies of the nation, of the raw materials needed in our mills, factories and workshops, and of our manufactures for export, and thereby the cost of living is advanced, the re-establishment of our industries and commerce is retarded, and the difficulties of finding employment are increased.

In these circumstances there is urgent necessity to relieve the railways of such traffic as can reasonably be carried coastwise.

The continued application of pre-war rates to the carriage of goods by rail offers strong monetary inducements to traders to use the railways for all goods, including those which can be sent forward as conveniently coastwise, but the unrestricted use of the railways is interfering with the flow of traffic through the ports and thereby placing limitations on both imports and exports.

There is, therefore, urgent necessity to use to the full the coastwise services, but they can only be re-established on a pre-war footing by being assured of a reasonable amount of regular traffic. Full services cannot be maintained if they have to depend on the carriage of casual traffic which is from time to time shut out by the railways.

To meet these difficulties the War Cabinet have given directions to the railway companies that no goods which have been imported foreign, or which are intended for export foreign, shall be carried by rail between points which can be effectively served in whole or part, by coastwise carriage. For this purpose schedules of traffic will be prepared by the Home Trade District Transport Committees in consultation with representatives of the railway companies on those committees, and all goods included in such schedules, whether transhipment goods or otherwise, will be carried, in whole or part, coastwise, at the freights and charges then current, and on the terms and conditions set forth in the sailing bill, conditions of carriage and/or bill of lading form then in common use for other similar cargo carried coastwise.

The difference between the freights and charges so paid (other than demurrage) and the amount of the railway rates and charges which would have been payable if the traffic had been carried by rail, will be refunded by the Railway Executive Committee or their agent to the trader by whom the payment has been made. All applications for refunds must be lodged within three months of date of forwarding of the traffic.

All persons having goods to forward under this arrangement must lodge an application, written on a specially-provided form, with the Home Trade District Transport Committee for the district from which the goods will be consigned, and must follow the directions given by that committee as to the route and means by which the goods are to be forwarded.

Traders will greatly facilitate the prompt carriage of goods by lodging their application forms at least 10 days before the goods will be ready for shipment.

The districts for which Home Trade District Transport Control Committees have been appointed, and the address of the secretary of each of such committees to which all communications are to be sent, are given below.

This arrangement is entirely of a temporary nature, and subject to termination at any time.

Home Trade District Transport Committee.—Bristol (covering the Bristol Channel): Mr. E. A. Clark, 25, Great George-street, Park-street, Bristol. Glasgow (covering West of Scotland): Messrs. Purdie, Glen and Co., 55, West Regent-street, Glasgow. Hull (covering

the Humber and East Coast ports): Mr. T. W. Prickett, Land of Green Ginger, Hull. Leith (covering Edinburgh and East Coast of Scotland): Mr. G. C. Duff, 8-9, Commercial-street, Leith. London: Mr. O. C. Baylis, 1, Seething-lane, E.C. 3. Mersey (covering Liverpool, Manchester, Birkenhead and West Coast ports): Mr. J. W. Lester, 211, Tower Buildings, Liverpool. Newcastle (covering the Tyne and Tees): Mr. C. E. Hull, Mercantile Chambers, Newcastle.

THE BUILDING OF AIRSHIPS.

To the Editor of Engineering.

SIR,—I am venturing to write to you with regard to the letter under the above title which appeared in your issue of the 8th inst. Authoritative as Mr. Lightfoot's opinion is on many matters, in this case he makes several misleading statements due to his necessarily limited information, a limitation arising from the fact that the development of rigid airships in England has up to date been in Government hands, and the results of experience gained in possession of only a few officers of the Admiralty and Royal Air Force.

On the question of war utility of airships, Mr. Lightfoot's view is diametrically opposed to that of the greatest authorities on war. Lord Jellicoe in his book, "The Grand Fleet, 1914–1916" states that in fine weather, one Zeppelin is equal, for scouting purposes, to at least two light cruisers; further, the admiral cites numerous occasions when his operations were hampered by enemy Zeppelins. Lieutenant-General Freytag von Lahringhaven, in his book "Deductions from the World War," gives it as his opinion that while in certain types of military war, Zeppelins have ceased to be of value, in naval war their utility remains.

On the peace-time employment of airships, Mr. Lightfoot again finds himself opposed by weighty opinion: recently Major-General Sir J. Seely, in a speech (Airship Club, July 26) stated that he had been informed by Sir Charles Parsons that the airship possessed certain inherent advantages, and in the case of high speed transportation over the sea that he had no reason to doubt its ultimate commercial success. Certainly the consideration of *the power consumption per ton of useful burden for equal speeds* in the case of water-borne ships and airships (as instanced by the C.M.B. and R. 34) appears to show that high-speed transportation (60 m.p.h. and over) for long distances (over 500 m.p.h.) will be more easily and more economically obtained by the development of airships than by means of water-borne craft.

To reply briefly to some of Mr. Lightfoot's detailed criticisms, the danger of fire in a well-constructed airship is small as can be deduced from the fact that during the war, over 2,250,000 miles were flown by airships with the loss in the air of only one by fire arising from accident.

The success of mast mooring of both rigid and non-rigid airships (*vide* Sir J. Seely's speech, Royal Aero Club Dinner, to Major G. H. Scott) has been far greater than Mr. Lightfoot imagines, for while both classes of ship have been moored in winds above 40 m.p.h. (and the non-rigid in winds up to 52 m.p.h.) without accident, mast mooring has also the potentiality of reducing the landing party to an insignificant number. On the question of useful lift Mr. Lightfoot appears to be misinformed. We have been told officially that R. 34 possesses approximately 30 tons of useful lift and consumes about 700 lb. of petrol and oil per hour at full speed (60 m.p.h.), consequently the amount of commercial burden is calculable for any definite length of continuous flight.

In conclusion, while trying to reduce the magnitude of Mr. Lightfoot's criticisms to what in my opinion is their true proportion, I am fully aware that there are difficulties in the commercial development of rigid airships, but as these difficulties will only be overcome by experiment included in the Government programme, surely this is justified.

I am, Sir, yours faithfully,
"WINCO."

Godesberg, near Bonn, August 13, 1919.

STEAM ENGINE EFFICIENCY.

To the Editor of Engineering.

SIR,—In the very interesting paper read by Sir Dugald Clerk before the North-East Coast Institution of Engineers and Shipbuilders, which paper you published in your issue of July 18, there appears a statement to the effect that in 1914 the maximum terminal efficiencies obtained by a steam motor, in this case a large turbine, were 23 per cent. referred to the indicated horse-power and 19·5 per cent. referred to the brake horse-power. I assume superheated steam was used in the turbine when the above efficiencies were recorded.

I have obtained fully as high, or, in fact, higher efficiencies with reciprocating engines of moderate size without using superheat. In these engines I have used a regenerator feed water heating system whereby the temperature of the feed water is brought up to that of the first receiver of a quadruple expansion engine. Thus, in 1897, I designed a pumping engine operated with a steam pressure of 200 lb. The efficiencies developed with this engine were 22·8 per cent., based upon the indicated work and 21·2 per cent. on the effective work. The performance of this plant was made the subject of a paper read by Dr. R. H. Turston, of Ithaca, N.Y., at the New York meeting in December, 1899, of the American Society of Mechanical Engineers. The paper was entitled "The Steam Engine at the End of the Nineteenth Century." The indicated horse-power developed by this engine was a little over 700.

In 1905 I designed a larger engine on the same principle as the one just referred to. This engine was used in connection with an air compressing plant at the Champion Copper Company's mines in Northern Michigan. The capacity of this compressor was 9,000 cub. ft. of free air per minute to be compressed to 80 lb. gauge pressure and it was of quadruple expansion type, fitted with regenerative feed water heaters. The boiler pressure in this case was intended to be 300 lb., but it was found that the boilers were not good for that pressure, so that the boiler pressure was cut down to 250 lb. No superheat was used. The engine was tested seventeen months after it had been put in operation by Professor O. P. Hood, at that time Professor of Mechanical Engineering at the Michigan School of Mines. The efficiency obtained with this engine was found to be 25·05 per cent. on the basis of indicated work and 22·3 per cent. on the basis of effective work. These efficiencies refer to the heat in the steam delivered to the engine. The test was made under very disadvantageous conditions, as the steam was very wet, and the compressor had to be run at a very much reduced speed to suit the demand of air at the mine. The particulars of this test are found in a paper read by Professor O. P. Hood at the New York meeting, December, 1906, of the American Society of Mechanical Engineers, the said paper being entitled "A High Duty Air Compressor."

I may add that this air compressor has been running without interruption since the time it was first started in 1905 and the regenerative feed water system with which this machine is fitted has proven itself to be absolutely reliable and free from all troubles. In fact, the only trouble experienced with this machine has been too rapid wear of the high pressure cylinder due to the wet steam.

Yours respectfully,
BRUNO V. NORDBERG,
Chief Engineer, Nordberg Manufacturing Company,
Milwaukee, Wis., August 14, 1919.

A THEORY OF THE ACTION OF WATER AT CHANNEL BENDS.

To the Editor of Engineering.

SIR,—The old Italian theory of the action of water at a bend of a river was that the scour of the banks and bed was caused by the direct action of the water impinging on the bed and banks, and that one bend in one bank caused the water to impinge against the opposite bank and cause a bend there. Subsequently the theory that the water flowed round the bend under the influence of the radial or centrifugal force was introduced, mainly it would seem in order to construct a formula for the outward movement of bent pipes. Otherwise there does not seem to be much alteration, though the original theory has not been found to give an adequate explanation of what occurs.

If scour depended on the force of the water impinging on the banks, the amount of scour would bear some relation to the velocity of the water, but, with the exception of the scour of the banks usually taking place when the water in the channel is flowing at a higher level than usual, there does not seem to be any proof that this is the case.

If the scour depended on the velocity of the water, there would be a steady wearing away of the banks, but this is not found to be the case, the scouring of the banks occurs when there is a flood in the channel and the banks become saturated. The scour does not seem to be a wearing away of the banks, but is of the nature of a land slide. Masses of earth fall into the water and are carried away. The effect of these landslides is often bad enough, but it is nothing to what would occur if the scour was caused by the direct action of the water impinging against the banks.

It seems necessary to endeavour to find some other theory for the action of water flowing round a bend that does not involve any pressure on the outer banks in excess of the pressure that would occur on the banks in a straight reach, whether the excess pressure is caused by direct action of the water impinging on the banks or by any radial force.

When water flows freely as in a channel it moves in an entirely different manner to the movement of a solid. It does not move under the influence of the particles above pushing the particles below, but by the particles below moving and the particles above moving to take their place. Water can neither push nor be pushed, unless it is confined, as the particles can be separated without practically any force.

The movement of particles moving round a bend will be affected by the movement of those in front. The direction in which any particle is moving must be influenced by the direction in which the particles in front are moving; so in considering the direction in which the particles of water move round a bend, it is necessary to consider that they are acted on by a force in their original direction and a force which acts in the direction the particles in front are moving. There does not seem to be any name for this latter force, it would probably be best expressed by calling it the "Force of continuity of flow," as it is the result of the necessity of the flow of water to be continuous.

When water flows round a bend it may be said to do so under the influence of the force in its original direction and under the influence of the force of continuity of flow, with the result that the direction is constantly changing.

Suppose the particles of water entered the bend with equal velocity and were acted on by the force of continuity of flow, which may be assumed to be the same in amount for all particles, the effect would be that all the particles would tend to move in a path of the same curvature. The natural result of this tendency is that the water would converge from the sides to the centre. If it is taken that the particles in the central axis of the stream enter the bend at a greater velocity than that near either bank, and it is allowed that the greater the velocity the larger the radius of the path of the flowing water, the result would apparently be that the major volume of water would flow near the outer bank and less near the inner bank. The heaping together of the water on the outer bank would cause a rise of the surface and consequent scour on the bed. After the bed was sufficiently scoured out there would be no rise of the surface, equilibrium would be restored. At the inner side of the bend the water would flow away from the bank and there would be a lowering of the surface from the centre to the inner side of the bend, owing to there being less volume of water. The space between the inner bank and the current would be filled by still water or by vortices. If the water is still, or nearly so, it would be replaced by a deposit of silt. A deposit of silt would also be deposited on the bed, under the same conditions, from the inner side towards the excavated portion at the outer side. This deposit of silt might cause a rise of the surface, as the depression of the surface on the inside of the bend is due to the absence of sufficient water to fill the space, and eventually restore equilibrium, but there does not seem to be anything to necessitate it.

The silting process is assisted by a cross current from the outside along the bed, due to a difference of pressure on the bed, and this will continue till silting and scour ceases or equilibrium is restored.

In the case of a bend in pipes it is known that water leaves the inner side, if the bend is at a less angle than is suitable to the velocity, the space between the pipe and the current being filled with air, still water, or vortices. It is this reduction of pressure on the inner side of the pipe that causes the tendency of the movement of the pipe outwards. In order to understand the action, suppose both hands were put inside an ordinary silk hat and equal pressure was applied with both hands, the right hand pressing the inside to the right and the left to the left, the hat would not move, but if the pressure of right hand was increased the hat would move to the right and the same would happen if the pressure of the left hand was decreased. The increase of pressure to the right may be called "positive pressure" and the decrease of pressure on the left "negative pressure." The net effect in both cases is the same and the formula for a radial positive force is equally applicable in the case of a radial negative force.

There does not seem, therefore, any necessity for the outward pressure on the bank at the bend to be any greater than the pressure on the banks in a straight reach.

In the case of a jet of water in air impinging on a plate, the jet splits up after contact, consequently the force of continuity of flow is absent, the action is entirely different from that of ordinary flow, being somewhat the same as if the fluid was a solid.

As regards the erosion of the banks it may be taken that the cause is landslides; the initial cause of a bend in a straight reach could not possibly be due to the action of the water passing round a bend, but it could be due to a landslide, and many landslides in the same part of the channel and on the same bank would cause a bend. It is probable that the effect of the bend is to make the conditions such that the landslide is more probable at a bend than elsewhere in the channel, the fact that at a bend in a channel there is deep water near the outer bank would seem to be a sufficient reason. The undercutting of the banks during low water by waves and other natural agencies is sufficient to cause a landslide when the water is high and the banks are saturated, waves would be more powerful where the water is deep than elsewhere.

It does not seem necessary to mention any of the other numerous causes of landslides, they are too well known.

It is perfectly true that one bend causes another bend to form on the opposite bank; if one bend is made on one bank of a straight reach, there must be a bend on the opposite bank above the original bend and one below, the water must turn a corner to flow into the bend and turn another corner to get out of the bend into the straight reach; it does not seem possible for it to be otherwise. If a landslide occurs at either of these two bends thus formed and the bends are increased, they in their turn will cause other bends for the same reason.

It is therefore possible to form a theory of the action of water flowing round a bend in a channel which is essentially different to the old Italian theory.

I am, yours truly,
L. L. WICKHAM.

ELECTRICAL PRECIPITATION OF TAR FOG.—The removal of tar fog from coal gas is a troublesome operation, but is very essential, for instance, in the direct ammonia process. According to a communication presented by G. Davidson to the Canadian Mining Institute (Transactions, 1918, pages 252-258) the Cottrell process of electric precipitation is quite able to deal with the crude gases produced in the distillation of coal, wood and petroleum, even at the high temperatures used in modern industrial processes, whilst the usual methods of tar fog removal in extractors require cooling of the gases. Davidson obtained cleaner distillates with electric precipitation than formerly. The treater chamber he used consisted of an iron pipe, 15 ft. high and 12 in. in diameter, provided with fused quartz insulators; he passed about a million cub. ft. of gas through his heater per day, and his heater requires about 2 h.p. or 3 h.p.

THE WATT PUMPING ENGINE OF 1776 AT SMETHWICK.

Amongst the numerous attractive items included in the programme of the James Watt Centenary Commemoration to be held at Birmingham on September 16, 17 and 18, is a visit to Ocker Hill to examine one of Watt's early pumping engines which will be shown working under steam. This engine, which was built in 1776, was originally erected at Smethwick for pumping work in connection with the Birmingham Canal, and it remained there until 1898 after working for more than 100 years. When it was taken down it was, due to the action of Mr. G. R. Jebb, at that time engineer to the Canal Company, re-erected at the Ocker Hill Canal Works, where it has been maintained in working condition. We are glad to learn that the Board of the Birmingham Canal have now offered to give the engine to the Centenary Committee on condition that they can provide a suitable house for it and guarantee that it shall be properly looked after for the future. It is greatly to be hoped that the funds placed at the disposal of the Centenary Committee will permit of this offer being accepted, as the engine would form a most valuable addition to the collection of Watt relics which it is proposed to organise. We give on the present page a view of this engine as it appeared when erected at Smethwick, our illustration being prepared from a photograph for which we are indebted to Mr. Jebb.

GOVERNMENT FUND TO ASSIST EXPORTS OF MANUFACTURERS.

The Board of Trade announce that an office will shortly be opened under management appointed by the Board for furnishing sterling credits in accordance with the scheme for assisting the exportation of goods to certain disorganised parts of Europe, which was referred to by the Prime Minister in the House of Commons on Monday, the 18th inst. The credits will be based on bills drawn in this country by the seller of the goods and accepted by the buyer, and will be subject either :—

(*a*) To the deposit with an approved bank in the country of purchase of currency, to an amount required by the office, or

(*b*) To a guarantee of currency of a required amount by an approved bank, or

(*c*) To arrangements for the handing over of produce of the buying country, or

(*d*) To the deposit of securities with the approved bank or the office under the scheme.

The office will fix periodically the amount of currency required to be deposited per 100*l.* sterling, and will have power to vary its charges according to the nature of each transaction. The credits will continue for such periods as the office may determine in each case, having regard to the economic prospects of the country concerned and the character of the business, but the maximum period will be three years. The charges for each period of six months will be on a rising scale, in order to induce early liquidation.

The office will be entitled (*a*) to take over and liquidate collateral pledges; (*b*) to have recourse against the acceptor of the bill for any deficiency; and (*c*) to have recourse against the guarantor.

The credits furnished will not, as a rule, exceed 80 per cent. of the prime cost of the goods sold, *plus* freight and insurance (including the charge made by the office). In special cases, however, at the discretion of the executive, the amount may be increased, but in no case will it exceed the prime cost *plus* freight and insurance (including the charge made by the office). If the proceeds of the bill are less than the prime cost *plus* freight *plus* insurance (including the charge made by the office), the loss represented by the difference will be divided between the office and the drawer of the bill in the proportion of four-fifths to one-fifth.

Business will be taken only through banks and on the reports of banks, and the aggregate amount of credit to be granted will not exceed 26,000,000*l.* The area and classes of goods to which the scheme relates will be settled from time to time by the Government, but credits will not be furnished either for the export of raw material or for the sale of stocks held by Government departments.

The Faraday Society.—The offices of the Faraday Society have been removed from 82, Victoria-street, S.W., to 10, Essex-street, Strand, W.C.2. Mr. F. S. Spiers, B.Sc., remains secretary of the society.

Commercial Analysis of Ferrosilicon.—A complete analysis of ferrosilicon involves the determination of many elements in addition to iron and silicon, viz., carbon, manganese, phosphorus, sulphur, calcium, magnesium, barium, and aluminium, and as direct determinations are difficult and laborious, some elements comprising silicon itself being sometimes estimated by the difference in method. In bringing the subject before the American Electrochemical Society at their general meeting of 1918 (which took the form of a trip through the principal industrial centres of the Appalaechian South of the United States; the Transactions were recently issued), Earl M. Anger, of New York, insisted upon the necessity of very careful sampling of the ferro-silicon. In high-grade alloys the segregation of the silicion from the iron silicide is very pronounced, the silicon going to the top when the cast is cooling. For the determination of the silicon itself, Anger opens the alloy up with sodium carbonate; in alloys of more than 25 per cent. of silicon, this melt would attack the platinum crucible, and the carbonate is replaced by sodium peroxide rather than by sodium hydroxide, in iron (not in nickel) crucibles. These recommendations were questioned by H. R. Power, of the Carborundum Company, who prefers nickel and the peroxide.

ON THE RAPID SEASONING OF JARRAH.*

By ALFRED TOMLINSON, M.Sc., Assoc.M.Inst.C.E., M.C.I.

WITHIN recent years considerable interest has been awakened in the timber industry in connection with the so-called artificial methods of seasoning timber. In Western Australia rapid seasoning methods have, hitherto, been largely unsuccessful. Positive results, however, have been obtained lately on Jarrah and Karri, and the purpose of this short paper is to introduce and analyse respectively the methods and results of these investigations.

Mr. H. D. Tiemann, of the United States Forestry Service, has probably done more than anyone else to foster the interest in kiln drying, and only those who have considered the problem can truly appreciate the work he has done. The author wishes to acknowledge his indebtedness also to Mr. C. E. Lane-Poole,† Conservator of Forests, and to Mr. A. McNeil, Millars' Timber and Trading Company, and also to the senior engineering students at the university, particularly Mr. T. Cullity, B.E.

Introduction.—Wood, next to stone, is doubtless the earliest material used by man, and has served his needs more than any other substance. Many kingdoms have risen and fallen and become extinct, as the forests have flourished, been wantonly destroyed and perished. Although wood has been in use so long and so universally, there still exists a remarkable lack of knowledge regarding its nature, and so it is often treated and used in a faulty and wasteful manner. The reason for this imperfect knowledge is probably due to the fact that wood is a direct product of vital processes, and thus necessarily presents variations, possessed by all living species, which place it in a category somewhat different from that of mineral or manufactured substances. Cellular structure in wood and the qualities that attract and nourish micro-organisms have no counterparts among the inorganic materials. Evidently, it is difficult to study timber for the purpose of establishing general laws. Thus, experience shows that all methods of seasoning are not suitable for all woods. However, as will be seen later, certain laws or principles have recently been established in regard to drying timber, and adjustments, obtained by direct experience, are merely required to select the proper method in any particular case.

Necessity for Seasoning.—Woods deteriorate, or fail, from use (wear and tear), exposure (expansion and contraction), age (brittleness), decay (fungous diseases), fire, marine life and land life (woodborers); and they are defended more or less successfully by seasoning, internal and external treatment. The term seasoning, as is well known, refers to certain processes designed to remove water from timber. Woods dry, shrink, are sterilised and cured, and otherwise improved by these processes, as moisture greatly affects the physical properties, and the removal of excess of water causes the wood to dry, shrink, gain appreciably in strength and stiffness, and decrease in weight. The durability of the wood is also increased during the drying process owing to the preparations contained in the sap that are of an organic putrefactive nature undergoing radical alterations. The alterations are of such a nature as to suggest the changes that take place in fruits when they are sterilised and cured. Since it is natural for felled timber, dead wood, as with other product of life processes, to rot and decay, seasoning must be regarded as an artificial process. It may be noted that in nearly all cases seasoning precedes internal or external treatment, the latter, however, will not be dealt with in this paper.

Drying and Shrinkage.—It is an easy matter to merely dry wood, but it is difficult to dry it so that every part will shrink together. At the outset it must be recognised that drying wood is not simply a matter of evaporating moisture, as in the case when drying, say, clay or fabrics. Wood, when drying, checks or splits, more or less. This is due to the uneven drying out of the wood and the consequent strains exerted in opposite directions by the wood fibres in shrinking. However, as will be seen later, it is possible to control, more or less, this checking or splitting by arranging for the wood substance to be kept in a plastic state during the greater portion of the drying operations.

Drying Combines Two Problems.—The drying of wood is an art which properly combines two distinct problems, viz.: One has to do with the physical conditions involved in the extraction of the moisture without injury to the material, and the other is concerned simply with the means for evaporating moisture. These will now be dealt with in order.

Physical Behaviour of Wood under Heat Treatment.—Wood is composed of innumerable minute hollow structural units known as wood cells or wood elements, which form a network making up the wood tissue. These cells differ from one another in shapes and sizes, in the thickness and surfaces of their walls, and in the ways in which they are arranged. Briefly, the arrangements of the wood elements in soft woods is, on the whole, simpler than in the hardwoods, so that shrinkage effects in the former are not so complex as in the latter. It is obvious, therefore, that the seasoning of softwoods is a simpler proposition than that of hardwoods. Of the materials associated with the wood elements by far the most important is water, which acts by distending the wood elements, and thus making them weaker and more pliable.

Fibre Saturation and Shrinkage.—Freshly cut West Australian wood contains anywhere from 30 per cent. to 250 per cent. of the dry weight of the wood in water. If kept in the air long enough, the moisture content of the wood finally comes into equilibrium with that of the surrounding atmosphere, and may be taken as 9 per cent. to 12 per cent., depending on the season.

Observation shows that water exists in wood in two conditions:—

(i) As free water contained in the cell cavities (*i.e.*, small particles).

(ii) As fibre moisture absorbed in the cell walls (*i.e.*, hygroscopic).

When containing just enough water to saturate the cell walls the wood is said to be at the fibre saturation point. Any water in excess of this which the wood may contain is in the form of free moisture in the cell cavities. As might be anticipated, by likening the wood tissue to an ordinary sponge, removal of the free water has usually no apparent effect upon the properties of the wood except to reduce its weight, but as soon as any of the fibre moisture is removed structural changes take place in the cell walls and the wood begins to shrink. Since the free water is the first to be removed, shrinkage does not begin, as a rule, until the fibre saturation point is reached. In the case of Jarrah and other eucalypts, and some of the oaks, however, shrinkage begins well above this point. For most woods the fibre saturation point corresponds with a moisture content of 25 per cent. to 30 per cent. of the dry weight of the wood. With Jarrah, shrinkage begins even when green, with a moisture content of 70 per cent., say, and continues until dry. For this reason, it has been found difficult to obtain the fibre saturation point. This all-important point has, however, recently been established, its value being about 30 per cent., and the details of the investigation are given in Appendix II. It is believed that the contraction at first (green to fibre saturation point) is due to a form of collapse of the cells and afterwards (fibre saturation to dry) to the "true" shrinkage of the cell walls.

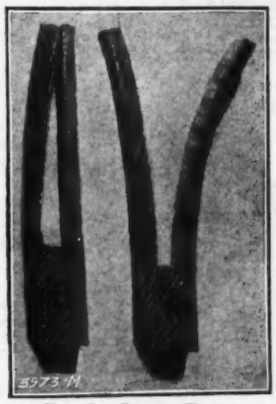


FIG. 1. PRONG TESTS.

How Wood Dries.—Clearly, an understanding of the phenomena which takes place as wood dries is of fundamental importance. In all seasoning processes the removal of moisture is entirely by surface evaporation, and the interior water must pass from cell to cell until it reaches the surface. A movement of water between any two portions necessitates a gradient of moisture condition, or a difference in temperature, and evidently the surface must be drier than the inside. Again, the "maximum" rate of drying is reached when moisture is evaporated from the surface of the wood just as fast as it is transmitted from the interior. Exactly how the moisture passes through the wood is not known. Experience justifies the belief, however, that if this rate of evaporation is exceeded the columns of free water, with their wick-like action, become interrupted or broken with air between, and a retardation of the transfusion of free water from the inside takes place: the fibre moisture begins to evaporate from the surface, which sets (*i.e.*, surface plasticity is destroyed), and a case-hardening takes place. If this maximum rate is not exceeded, a continuous flow of the free water from the interior to the surface takes place until the free moisture has passed off and the fibre saturation point reached. On further drying, evidently the fibre moisture must pass outwardly to the surface through the substance of the cell walls themselves, and not, as the free water, through the cell cavities or pores. The fibre drying operation is now comparatively simple, although obviously much slower than when evaporating the free water. Thus all drying curves show a considerable slowing down near the fibre saturation point.

How Wood may be Injured in Drying.—In drying, wood may be degraded or injured through checking or splitting, case-hardening, honeycombing, warping or twisting, and collapse. These defects, as pointed out before, are caused by unequal shrinkage, and the matter is dealt with at length in Appendix I. Briefly, checking, case-hardening and internal checking or honeycombing is due to the outside of the wood drying considerably faster than the inside; warping or twisting is due to uneven grain, irregularities and blemishes, or bad stacking; collapse is due to wet wood and high temperatures. Prong tests will indicate the state of strain or particular degrading tendency due to uneven drying across a section. Fig. 1 shows sections cut from jarrah boards with a strip sawed from the centre of each section. If the outside is appreciably drier than the inside, but above the fibre saturation point, the stresses cause the prongs to curve outwards as at A. The degree of curvature may be taken as a measure of the tendency to check or split on the outside. If the outside of the board has reached the fibre saturation point and is appreciably drier than the inside, the stresses cause the prongs to curve inward as at B, and bind on the saw. This indicates case-hardening, and, as before, the curvature may be taken as a measure of the tendency to inside checking or honeycombing. It must be noted that in prong tests the presence and type of objectionable stresses in the timber should be apparent immediately after sawing. The subsequent behaviour of the prongs when left in the air represents a development which has materialised after the timber has left the kiln. (See Appendix I.)

Humidity in Drying.—Observation shows that if dry heat is applied to the wood the surface will become entirely dry and case-hardened, often before the interior moisture is heated, let alone removed. The cause is due to the fact that the surface evaporation is too rapid; for the surface must be kept soft and moist, and the pores left open until all the moisture within has been evaporated from the surface. It has been seen that for successful drying, the surface evaporation should not exceed the rate at which the free moisture is transmitted from the interior. Evidently, the humidity of the air at the surface will be the controlling factor. For success it will be necessary then to arrange for the humidity (often 85 per cent. at commencement of operations) to be such that it will prevent the surface from drying much below its fibre saturation point until all the free water has evaporated. When the free water has finally evaporated, the crucial point in the drying has passed, and there is little danger then of injury to the wood. The relative humidity may then be gradually reduced (say, ultimately, to 40 per cent.) to remove the fibre moisture.

Seasoning Processes.—Three groups of processes are employed to season woods. They are air or yard seasoning, water-seasoning, and kiln seasoning. In general, from two to four years must often pass before 1-in. boards are dried by air seasoning. It is expensive to hold stock so long, and it is dangerous because of fires. In particular, it is believed that the climatic conditions obtaining in Western Australia militate against a reasonable control of air seasoning operations on the comparatively difficult to season native hardwoods, such as jarrah and karri. Air seasoning requires so much time, that it is frequently combined with some other method. Before woods are thus yard seasoned they are often soaked in water, and sometimes drying commenced by this method is completed in a kiln. Kiln seasoning originated with attempts to prevent warping and checking in special pieces. In the United States of America nearly all hardwoods, save those in large construction pieces, are now seasoned by the kiln method. Drying proceeds rapidly, and details, such as humidity, can be controlled in kilns as they cannot be in air or water seasoning. It is believed that the necessity of shortening the time required for the drying, and the advantages of producing uniform and reliable material will nowadays compel us to resort to artificial methods, and so kiln drying alone will be considered in what follows. There are many details and combinations, but the factors that influence kiln design and operation in all cases are circulation, humidity and temperature.

Conditions and Control for Evaporating Moisture in Kiln Drying.—Consideration will now be given to the second problem, before referred to, in the art of drying timber, namely, "the means for evaporating water in wood." On analysis, it is found that for a kiln to give satisfactory results it is necessary that the fundamental important conditions, viz., circulation, humidity and temperature, should be under proper control. If any one of these conditions is faulty, bad results must be expected. In the dry kilns, moisture is removed from the timber by surface evaporation only, and this requires heat. If only a few pieces of timber are to be dried, it is possible to heat them by radiation or conduction, but with a stack of timber the heat must be conveyed into the interior of the stack by convection or n ovement of the surrounding medium, usually air or steam. Again, movement is required for the removal of the evaporated moisture. Evidently, movement or circulation is necessary for drying to take place at all, and so is of first importance. The humidity is of next importance, because upon it depends the control of the proper drying of the timber. We have seen that by using a high humidity the surface of the timber is maintained in a moist condition, while the water is being drawn from the interior of the wood; too low a humidity will generally result in checking, case-hardening and honeycombing. The temperature depends upon the species and condition of the timber. Obviously, it is advantageous to have as high a temperature as possible, both for economy of operation and speed of drying, but the physical properties of the timber will govern this.

Theoretical analysis shows that the use of water vapour, below or above atmospheric pressure, with no air present as a circulating medium would be the most economical way to dry. In practice, however, owing to the practical difficulties arising, it is found that the air is the most efficient medium. Calculation shows that about 1,000 cub. ft. of air are required to theoretically evaporate 1 lb. of water under kiln conditions, so that a large amount of air must be brought in contact with the wood in order to dry it. The proportioning of the kiln as well as the arrangement of stacking the timber to be dried also must be carefully studied (Fig. 5). For it is necessary that the moving air come in contact with every portion of the timber to be dried. If the air stagnates when in contact with the timber, the temperature will drop and the humidity will rise to a condition of saturation, so that drying cannot take place and the timber will tend to rot. Again, experience shows that the natural air movement through a stack of moist timber is in a downward direction. This is not self-evident. However, calculations show that in the usual

* Paper read before the Western Australia Institution of Engineers, at Perth, on May 14, 1919.

† See Bulletin No. 1, W.A. Woods and Forests Department.

kiln operations the combined result of spontaneous cooling and increase in humidity increases the density sufficiently to cause the air to descend. Provision must be made in stacking to comply with this principle. Another principle of equal importance is that the stacked boards should not be placed so as to baffle the air currents, otherwise the moving air will short-circuit the stacks and not pass through them. In the case of movement of air by fans or blowers through a stack of timber, the motion is due to differences in pressures, and between any two portions of the kiln which differ in pressure the air will flow along the path of least resistance. Since the resistance of various portions of the pile must necessarily differ greatly, the velocities of the air will also differ accordingly. In this respect forced draught differs essentially from natural circulation produced by differences in density. Natural circulation is also self-adjusting. Again, unless the draught is invariably in the same direction as the natural tendency, it will operate against it. For these reasons forced draught of itself is not apt to give uniform drying, except when it is properly combined with the natural system. In choosing a kiln the control of the three fundamental conditions, together with the other principles mentioned above must be carefully considered. It is found that commercial kiln drying failures are usually due to faulty circulation.

Types of Kilns.—There are dozens of kilns on the market. Present practice in kiln drying, in the various parts of the world, varies enormously. Even with the same species of timber and for the same purpose, all kinds of conditions are met with. Temperatures vary anywhere from 70 deg. to over 220 deg. F., and 1 in. timber, requiring from two months' to thirty months' yard seasoning, is kiln dried in from two days to six weeks. Usually hardwoods are dried at a much lower temperature than softwoods. The dry kiln, however, has been one of the most troublesome factors arising from the development of the timber industry. For, unfortunately, until recently proper methods of seasoning have received little scientific attention. Forms of kilns, and mode of operation, have in the past commonly been merely copied by one wood-working firm after the example of some other older establishment. Thus, to put it mildly, present practices have many shortcomings, and methods of drying "difficult to season timbers," such as hardwoods, have often been on wrong lines.

Kilns for drying timber may be divided into two classes, viz.: (i) Progressive, and (ii) compartment. For convenience in handling, the timber to be dried is usually in trucks on rails. In a progressive kiln (Fig. 2) the conditions at one end differ from those at the other, and the timber is dried progressively by being moved throughout the whole kiln. The air circulation is longitudinal, so that the conditions during drying vary, more or less uniformly, from one end of the kiln to the other. In compartment kilns (Figs. 3 and 4) the conditions are changed during the drying process, and the timber remains stationary and is all dried at one time. The air circulation is transverse, so that the conditions at any time during drying are uniform throughout the whole kiln. The methods of operation generally used may be placed under the headings:—

(*a*) Non-condensing.
(*b*) Superheated steam.
(*c*) Condensing.

In (*a*), the humidity or dampness is controlled by the use of escaping steam and evaporated moisture (Fig. 2). The circulation may be either natural or forced, and the moist air is allowed to escape from the kiln. Softwoods and "comparatively easy to season woods," such as pine, ash and cedar, are usually dried by this method, the kiln being of the progressive (i) class. These kilns, however, are only very roughly under control and may be regarded as not being positive enough for hardwoods, especially if they are "difficult to season."

In (*b*), superheated steam is passed over the timber, either by natural or forced draught, in compartment (ii) class (Fig. 3). Obviously, the method may be used only where the special to be dried are not injured by high temperatures, and where quick drying is essential. Many of the softwoods, such as pine and ash, are successfully dried by this process, but the hardwoods, especially the hard dense, such as oak and walnut, are materially injured.

In (*c*) the humidity is controlled by re-circulating the air, which has taken up moisture from the timber, across water pipes or through water sprays (Fig. 4). The temperature of the pipes or sprays governs the amount of water that condenses from the air, and thus regulates the humidity of the air when re-heated before being passed over the timber again. The circulation of air may be either natural or forced. These kilns of the compartment (i) class are under proper control, and for this reason it is believed that all kinds of woods, soft and hard, including the eucalypts, may be successfully dried by this condensing method.

It appears, then, from the kiln three fundamental conditions analysis, that the kiln for drying the hitherto "difficult to dry" eucalypt hardwoods should be the condensing compartment type. Experimental kilns of this type, using the Tiemann water spray principle, were designed and erected at Millars' Nash-street yard and at the Department of Mining and Engineering, University, Crawley, the kiln at the latter being of commercial full-size cross-section. The results of investigations on local hardwood have fully justified the original belief, namely, that the Condensing compartment method was the solution to the seasoning difficulty. The kiln at Crawley, as stated before, is of the condensing compartment type, with natural and partly forced circulation. The main feature is the humidity control by means of water sprays introduced by H. D. Tiemann, of the United States Forestry Service.

Fig. 2.

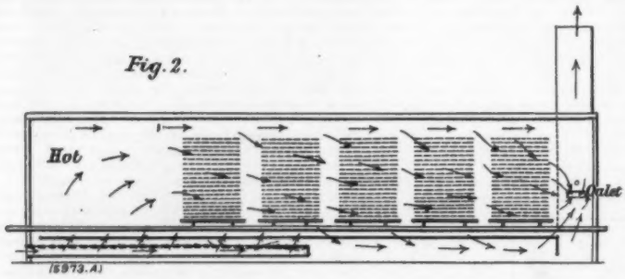


Fig. 2. Progressive Class (1): (*a*) Type: Longitudinal Section of Kiln. Arrows show the Direction of the Circulation. Timber Stacks moved from Right to Left.

Fig. 3.

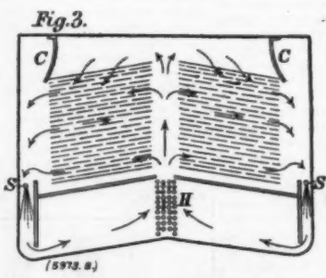


Fig. 3. Compartment Class (2): (*b*) Type: Cross Section of Kiln. Timber Stacks remain Stationary. S, Superheated Steam Jet; H, Heating Coils.

Fig. 4.

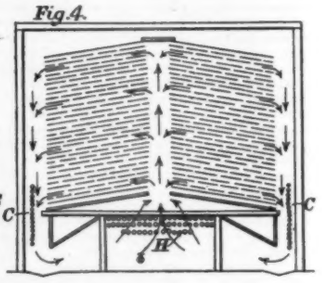


Fig. 4. Compartment Class (2): (*c*) Type: Cross Section of Kiln. Timber Stacks remain Stationary. C, Condensers (or Sprays); H, Heating Coils.

Fig. 5.

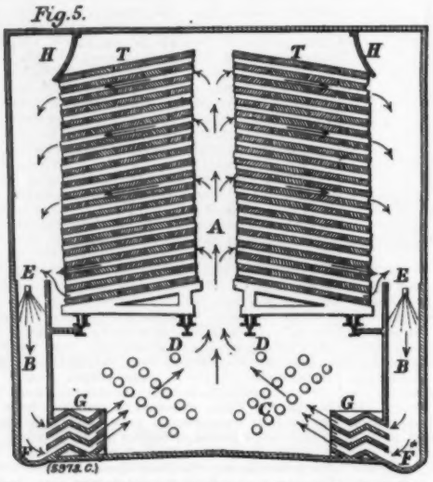


Fig. 5. Diagrammatic Cross Section of Kiln at University, Crawley. Inside Dimensions of Kiln: 12 Ft. 6 In. Wide by 14 Ft. 9 In. High. Timber Stack: 4 Ft. Wide by 8 Ft. High.

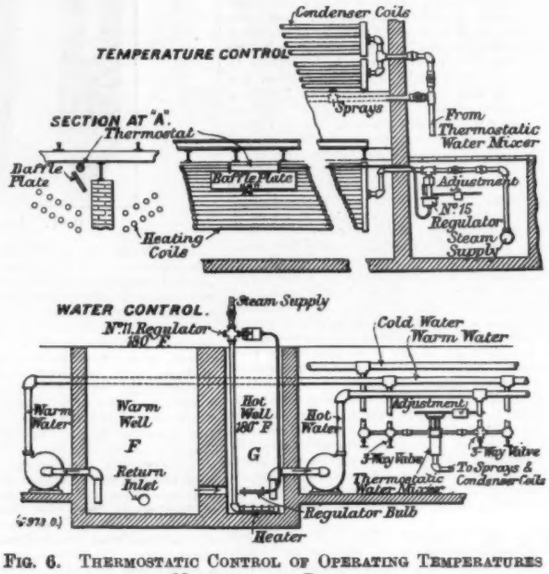


Fig. 6. Thermostatic Control of Operating Temperatures (Maximum and Baffle).

Condensing Compartment Kiln (Tiemann Principle).—Briefly, the kiln (see Fig. 5) consists of a drying chamber A containing two lines of trucks T carrying the timber to be dried, with a partition on either side running the whole length of kiln, making two narrow side chambers B, open top and bottom. The steam heating pipes C, and pipes D for admitting live steam, are placed underneath the material to be dried. At the top of the side chambers B are water sprays E, at the bottom are gutters F, and eliminators or sets of baffle plates G, to separate the fine mist from the air. Curtains H are hung from the roof to the edges of the stacks, as shown, to prevent the air from passing over the stacks and thus short-circuiting them. The circulation of the air is shown by the arrows. Thus the heated air rises in the flue between the two stacks of timber. As it comes in contact with the stacks, parts of it are cooled and forced to pass outwardly through the stacks to the spray chambers. The movement through the stack is naturally diagonally downwards, and the inclined stacking of the timber ensures that this course is not unduly resisted, otherwise poor circulation is apt to result. In the spray chamber the velocity of the descending column of air is greatly augmented by the sprays. It then passes out through the baffle plates, is heated by the radiators, and commences on its upward course again. Besides

inducing an increased circulation, the spray may be said to regulate the humidity. In the side chambers the sprayed air in descending absorbs as much water as it can hold in the form of water vapour. It also becomes misty, for it mixes with small particles of free water. In the zig-zag baffles these particles of water are eliminated, and merely saturated air emerges into the main chamber. Evidently the cycle of operations is as follows: At the bottom of the main chamber the air, at baffle temperature and 100 per cent. humidity, in passing over the heaters, increases in temperature and decreases in percentage humidity. When moving through the timber stack it is gradually cooled through absorbing moisture, and thus continually decreases in temperature and increases in percentage humidity, until, after passing through the spray chambers, it emerges from the baffles into the bottom of the main chamber again with the same baffle temperature and 100 per cent. humidity as before. It is evident, therefore, that the baffle temperature is the dew-point of the air after it becomes heated in passing through the radiators. Knowing the dew-point and maximum temperatures in the kiln, by means of tacles, humidity diagram or psychrometric charts, the minimum humidity of the kiln may be quickly determined at any time. Thus only two stationary thermometers are necessary for determining the humidity and temperature of the air entering the timber, and therefore, for operating the kiln, one in the baffles at G, which thus records the dew-point, and the other in the flue A, between the stacks of timber, which records the maximum kiln temperature. Neither

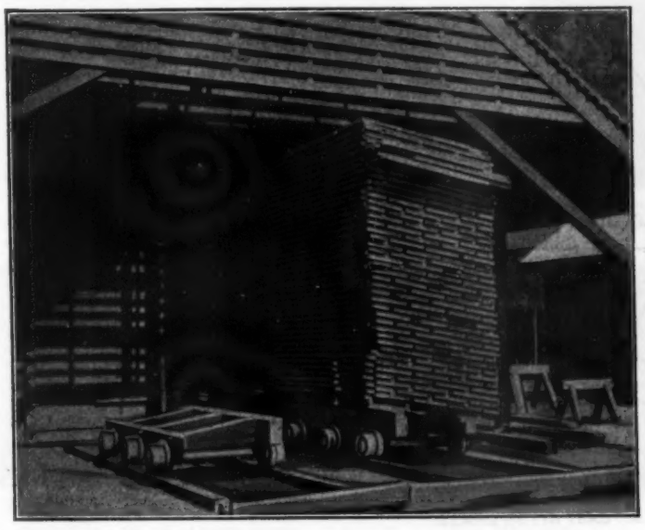


FIG. 7. BACK VIEW OF EXPERIMENTAL KILN AT UNIVERSITY, CRAWLEY, SHOWING CHARGE OF 12-IN. BY 1-IN. AND 6-IN. BY 1-IN. JARRAH RESTING ON TRUCK. THE SLOPE OF THE 8-FT. BY 4-FT. TIMBER STACK IS 1 IN 7. THE TRANSVERSE DISTANCE PIECES ARE 1-IN. JARRAH STRIPS.

a wet bulb thermometer nor hygrometer is needed. It is very convenient to use a thermograph or a recording type of thermometer having long, flexible, tubular connection with the bulb, and to have both hands recording on the same dial. The heating coils and sprays to give correct maximum and baffle temperatures, respectively, may be controlled by thermostatic devices. Upper portion of Fig. 6 shows a typical automatic installation of maximum temperature control with devices, manufactured by the Powers Regulator Company, U.S.A. The position of the regulator will be noted with regulator valve in the pit controlling the steam supply to the heating coils and governed by the thermostat so located as to be exposed to the kiln temperature. A baffle plate is arranged to cut off the direct influence of the heating coils upon the thermostat.

Usually the used spray water discharges into a well, and by means of a pump ultimately forced through the sprays again.

Lower portion of Fig. 6 shows a typical thermostatic water mixer which automatically supplies water of proper temperature to the sprays and condenser coils. The wells, F and G, are provided for the source of warm water and hot water, respectively. The well F receives its supply from the spray, and condenser coil returns. Well G may be supplied by the return water from the heating coils, and also with high-pressure steam, which is controlled by a thermostatic regulator, so that a maximum temperature of, say, 180 deg. F. is automatically maintained. The two wells are provided in order to economise in the use of both the cold water and the steam required in the operation of the sprays, and condenser coils, and so long as the temperature of the spray water is required to be lower than naturally exists in the warm well, the three-way valves are turned in such a way that the thermostatic water mixer receives its two supplies from the cold-water line and the warm well respectively. When, however, the spray water is desired at a temperature above that of the warm well, the three-way valves are reversed, so that the mixer is supplied on its cold side by the warm water, and on its hot side by the hot water from well G.

Construction.—It is not intended to offer here working plans or specifications of the kiln, but merely to give a sufficient description to make its construction plain. The drying kiln at Crawley, which is of the proper commercial section, is always available for inspection, and plans of the kiln may be seen either at the Department of Mining and Engineering, University, Crawley, or at the office of the Conservator of Forests, Perth. At Crawley kiln (Figs. 5 and 7), for convenience in loading and unloading, the rails are arranged to be at ground level. Below ground the outside walls of the kiln are of brick in cement, the floor being of concrete. On the top of the walls, and thus above ground, rests a simple framed wooden construction. Over all this is a shingle roof to keep out the weather and prevent excessive radiation. The kiln should be more or less airtight, and the inside of the kiln must be made waterproof. A certain amount of radiation from the side walls is desirable, since it increases the efficiency of the condensing system, the sprays, for the heat given to the walls does not need to be removed by the sprays. It is necessary, however, to insulate the top of the kiln—sawdust is quite satisfactory—in order to prevent condensation and drip on the timber piles. The vertical faces of the spray chambers must be both air and water-tight. The baffles are made up of boards in convenient sections. They should fit tightly, as any leakages will allow the spray to get through to the steam radiator pipes, which would spoil the humidity regulation. The water sprays consist of small brass nozzles of the easily-cleaned and adjustable "demorrel" type, which will deliver about 3 lb. of water per minute at about 40 lb. pressure. They should give a spray of water, and not a mist. The water pipes should be arranged so that it is easy for them to be inspected and cleaned. Galvanised pipes must not be used in the kiln. The steam radiators are constructed with 1-in. wrought iron pipes. The whole of the woodwork and iron inside the kiln should be coated with a good high temperature asphaltum varnish or P. and B. paint.

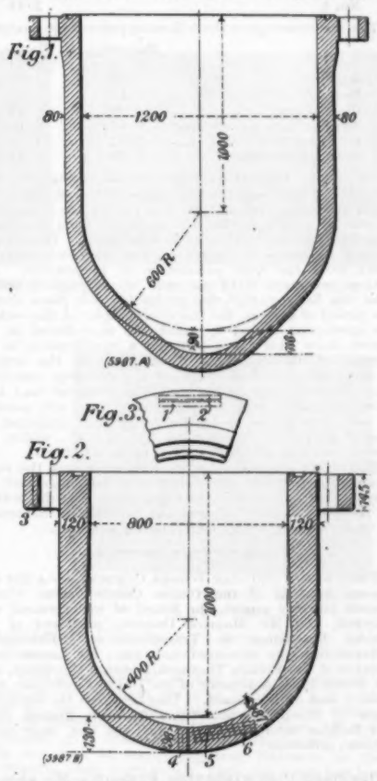
(To be continued.)

THE BRITISH CORPORATION SHIPPING REGISTER.—The Shipping Register recently issued by the British Corporation for the Survey and Registry of Shipping, gives a list of the officers and committees of that body, as well as a list of its surveyors in all the principal ports of the world. It also gives full classification particulars, and other useful information, relating to the ships classed by the corporation, as well as a list of registered, or managing, owners with particulars of their respective fleets. The corporation's rules for the classification and construction of steel ships, with tables of scantlings, are also issued in a separate book. Considering the origin of this latter publication, it is a rather remarkable fact that, in connection with certain formulæ, V is defined as the speed of the vessel in knots *per hour*. The Register is issued to subscribers only, the subscription being 2 guineas for individuals and firms, and 3 guineas for public companies, underwriting associations, and marine insurance companies. The rules and tables, however, are supplied for general use at the price of 15*s*.

THE FAILURE OF TWO AUTOCLAVES.

THE fiftieth annual report for 1918, issued by the Swiss Society of Steam Boiler Owners, Zurich, gives particulars of the failure in service of two autoclaves, or digesters. In one instance, a digester of semi-steel (*fonte d'acier*—steel casting ?), which had been in service in a chemical works, was distorted, due to being overheated; as will be seen by Fig. 1, the spherical end dropped about the centre line and cracked, and the liquid content escaped into the fire-box. The digester was of Swiss manufacture; it was directly heated at a distance from the grate of 0·52m. (20½ in.). The lower part internally had a thick deposit, due to the service required of the apparatus. The heavy deformation, 116 mm. (over 4½ in.) for a wall thickness of 90 mm. (3½ in.), must evidently have been the result of submitting the apparatus to a very high temperature. The apparatus was manufactured in 1915; the maximum registered pressure was 60 atmospheres; the explosion occurred at a pressure of 48 atmospheres and at a temperature of 265 deg. C. The society condemned the digester and had it replaced. In the case of the new one, they recommended placing the mixing device close to the bottom and increasing the distance between the grate and the digester.

In another chemical works, the bottom of a grey cast-iron digester, directly heated, also gave way (see



Figs. 2 and 3). The crack produced by the explosion had, in the cold state, an opening of from 5 mm. to 10 mm. (⅛ in. to ⅜ in.) in its central portion and a length of 0·5 m. (19½ in.). The liquid in the apparatus ran out in the fire-box. The digester was at a distance of 0·55 m. (21½ in.) from the grate. The apparatus, of foreign manufacture, was first used in the making of explosives, but this had been changed a few days before the accident, and fortunately so, for otherwise the consequences might have been disastrous. It was made in the year 1900; the maximum authorised pressure was 40 atmospheres and the apparatus had been tested to a pressure of 120 atmospheres. The dimensions are given in Fig. 2.

It is not possible to say at what pressure this digester exploded. The temperature had certainly reached 240 deg. C. The lower part was heavily worn internally, as shown in Fig. 2; the thickness was reduced from 130 mm. (5⅛ in.) to 87 mm. (3⅜ in.), a maximum wear of 43 mm. (1⅝ in.). Notwithstanding this fact, which was known to the society, the latter felt justified in allowing the apparatus to continue in service, since on the basis of a 40-atmosphere pressure the stresses in actual service were much below the normal ones. The explosion must have been due to other internal forces much above the working pressure, this being confirmed by the circumstance that the crack remained open in the cold state and when the piece was under no pressure, there being, in other words, a permanent deformation.

Inspection showed that the bottom part of the apparatus was covered by a 20-mm. (¾-in.) layer of chalky deposit, which must have greatly hindered the uniform transmission of heat. The temperature of the walls must have risen up gradually, and it is well known that grey cast-iron when overheated loses all

its resistiveness; growth, following repeated heating and cooling in the ordinary way, also comes in, quite apart from all consideration of overheating. This question of growth of cast-irons, we may add, has been frequently dealt with by the members of the Iron and Steel Institute, and we may recall a very interesting paper on the subject by Professor H. C. H. Carpenter, F.R.S., read before the Institute at the autumn meeting of 1909; judging from the report the society appears to be acquainted with Professor Carpenter's work in regard to this phenomenon.

Some experts, the report further states, may claim that the crack formed is the consequence of tensile stresses due to contraction and not to elongation of the metal. The report adds that it cannot say in what way the molecules became displaced, but that it can safely compare the occurrence with what takes place in the case of a grate bar, which curves out until it breaks at the part submitted to the highest tension; in the same way, the bottom of the apparatus lengthened out, or tended to lengthen out downwards until fracture occurred.

Test specimens were taken as shown in Figs. 2 and 3. Specimens having 200 mm. (7⅞ in.) between supports gave the following figures of resistance to bending, in tons per square centimetre:—

No. 1	2·56
No. 2	2·86
No. 5	2·86
No. 6	3·14

Two specimens gave the following percentage analyses:

	Bottom, No. 5.	Flange, No. 1.
Silicon	1·32	1·31
Manganese	0·42	0·42
Phosphorus	1·01	0·99
Sulphur	0·102	0·101
Total carbon	3·32	3·25
Graphite content ...	3·26	3·14

The Swiss Federal stipulations concerning the tests of steel bridges require that the material should withstand a bending test of 2·80 tons per square centimetre. It will be seen that the test specimen from the flange was the only one not to give this figure. There is no remark to make in regard to the chemical analyses, apart from the high percentage of phosphorus. The bottom contained 0·12 per cent. more graphite carbon than the flange; this rise probably took place during the period of service, for the micrographs of the ends of the specimens 3 and 4, which are reproduced in the report, show that there occurred a modification in the texture of the metal. In both instances the texture is very different from that of normal grey cast-iron. The micro-sections prove that the material had long been exposed to high temperatures. It is not possible to say what temperature the flange was subjected to, presumably from 200 deg. to 300 deg. C., whilst the bottom end was probably heated up to 500 deg. C.

The report concludes by advocating casting the autoclaves standing, the gate being over the flange and not over the bottom, for it is most important that the bottom be perfectly sound. It was not possible to determine in what way the vessel which failed was cast.

French and Belgian Works Combine.—At the last general meeting of the Usines Carels Frères, Ghent, French journals report, the board of management was renewed, and Mr. Maurice Despret, president of the Société Financière de Transports et d'Entreprises Industrielles, was appointed chairman; Mr. Lacaze-Levi, director of the French Thomson-Houston Company, and Mr. Pierre Boty, a director of the Union Electrique, were given a seat on the board. This betokens the establishment of business connections between French firms and Belgian interests which, until the war, were under German influence.

Gas-fired Case-hardening Furnace.—We gave on page 272 of our last volume an illustrated description of the "Revergen" annealing and heating furnaces fired by town gas, built by the Davis Furnace Company, Luton. Details of actual consumption figures of one of their "Revergen" furnaces on case-hardening work have now come to hand. The figures apply to an odd case-hardening job undertaken to oblige customers of theirs, whose requirements were that the material should be charged cold, raised to 900 deg. C., and maintained at that temperature for eight hours. The material consisted of automobile gear wheels, packed in six boxes, the total weight being 713 lb. The required temperature of 900 deg. C. was obtained in 70 minutes from lighting up, the records being as follows:—

Gas to raise furnace and charge from cold to 900 deg. per lb. 1.29 c. ft. = 925 c. ft
Gas to maintain 900 deg. for first hour, per lb. 0.38 c. ft. = 275 c. ft.
Gas to maintain 900 deg. for second hour, per lb. 0.42 c. ft. = 300 c. ft.
Gas to maintain 900 deg. for third hour, per lb.0. 38 c. ft. = 275 c. ft.
Gas to maintain 900 deg. for fourth hour, per lb. 0.42 c. ft. = 300 c. ft.
Gas to maintain 900 deg. for fifth hour, per lb. 0.49 c. ft. = 350 c. ft.
Gas to maintain 900 deg. for sixth hour, per lb. 0.49 c. ft. = 350 c. ft.
Gas to maintain 900 deg. for seventh hour, per lb. 0.45 c. ft. = 325 c. ft.
Gas to maintain 900 deg. for eighth hour, per lb. 0.45 c. ft. = 325 c. ft.
The overall gas consumption for the run of 9 hours 10 minutes was only 4.8 cub. ft. per lb. of load.

THE EFFECT OF WORK ON METALS AND ALLOYS.*

By Owen Wm. Ellis, M.Sc., Member (Woolwich).

1. *Previous Research.*—From a quantitative standpoint this subject has elicited considerable attention during the past few years, and a number of most interesting papers on it have been written, read, and discussed both in this country and abroad. It has long been known that the effect of cold work has been to raise the elastic limit, the yield point, the ultimate tensile strength, and the Brinell number of the metals and their alloys. The lowering effect of work on other tensile properties has also been recognised. Goerens has shown† that the tensile properties of steel are not the only characteristics of the alloy to be changed under the influence of cold work. The solubility of steel in sulphuric acid, its electrical resistivity, its maximum magnetic permeability are three only of many properties observed by Goerens to be profoundly affected by cold working. That the density of metals and alloys is lowered under the influence of cold work appears to have been conclusively proved—

Fig. 1. WORKED COPPER.

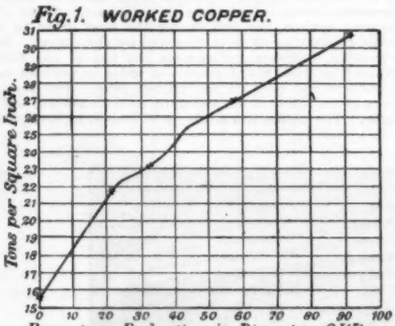


Fig. 2. CAST 61 : 39 BRASS.

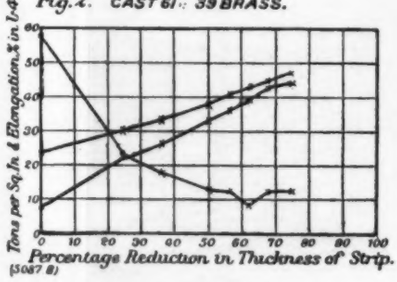
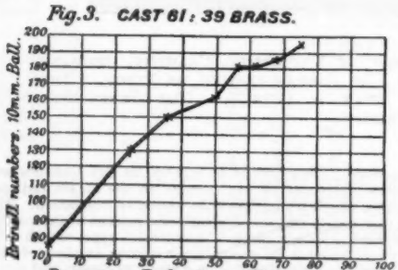


Fig. 3. CAST 61 : 39 BRASS.



it only requires to be shown that the mode of application of work is a determining factor in changing the specific gravity of the material undergoing work.

Most of the research hitherto carried out has been concerned with the alloys of iron and of copper and the precious metals. The softer metals, such as tin and lead, and their alloys, have scarcely been investigated. This is somewhat unfortunate, since many of the phenomena that confront us in the study of the properties of the cold worked "hard" metals and alloys might possibly be rendered explicable by a consideration of the properties of the cold worked "soft" metals and alloys. With regard to tin—in the rolling of tin the metal is not subjected to rolling in the sense that is understood by a majority of those dealing with the cold rolling of metals—the metal is subjected to a species of extrusion through the rolls. The processes of rolling and extrusion are, on account of the peculiar nature of this metal, combined when tin is passed through the rolls. Furthermore, annealing in the sense accepted generally is not resorted to; the metal is allowed to rest for periods of from 12 hours to 24 hours after reduction in the rolls. These facts are worthy of remembrance when considering the rolling of less plastic metals, such as copper and silver.

One has also to take into account the fact that most, if not all, of the researches so far carried out in the direction of the effect of cold work on the properties of metals and alloys, have dealt with more or less impure samples of the metals and alloys concerned.

2. *Previous Research on the Effect of Rolling and Drawing on the Mechanical Properties of the Metals and Alloys.*—In Figs. 4 to 11 of Goerens' paper* are shown the results of his research into the effect of cold working on the mechanical properties of iron and steel. These figures show the effect of cold work, in terms of percentage reduction of area by wire-drawing, on (1) the limits of elasticity (Figs. 4, 5 and 6); (2) the ultimate strengths in tension (Fig. 8); (3) the percentage elongations (Fig. 9); (4) the Brinell numbers (Fig. 10); and (5) the Shore numbers (Fig. 11) of a number of iron-carbon alloys. These diagrams, with perhaps two exceptions, fail to give any information concerning the effect of work upon the mechanical properties of the iron-carbon alloys beyond that already referred to in Section 1. The exceptional diagrams are Figs. 9 and 10. In Fig. 9 are shown a number of elongation-reduction graphs, all of which appear to be characterised by similarity of shape, *i.e.*, they suffer abrupt changes in direction at certain points in their course, which directional changes appear to vary according to the carbon contents of the alloys. The greater the carbon content of the alloy, the less the percentage elongation value at which the change in direction of the curve occurs. In Fig. 6 all the curves appear to suffer inversions at points varying in position with respect to the Y-axis from 10 per cent. to 30 per cent. in percentage reduction of area. There is an indefiniteness about all these curves (Figs. 4 to 11) which renders it inexpedient to draw conclusions other than those stated in Section 1. One might say tentatively that there are slight evidences of changes in the direction of the elongation and hardness-reduction curves of certain iron-carbon alloys.

Webster† has studied the effect of rolling and of drawing upon the mechanical properties of a number of non-ferrous materials. In Figs. 1 to 8 of his paper are depicted the results of his tests, which were made (1) on 0·1 in. sheet which, subsequent to annealing, had been reduced in the rolls to various thicknesses, and (2) on rods 0·5 in. in diameter, which were reduced by drawing to various diameters.

One obtains the impression, as a result of a study of Webster's curves, that the yield point and percentage elongation-reduction graphs all show distinct changes in direction at well-defined points in their length. Very similar curves for two types of brass rods (Figs. 7 and 8) show changes in direction at 15 per cent. and 30 per cent. reduction respectively. The graph for silver appears to undergo such a change at about 25 per cent. reduction; that for Monel metal varies uniformly, and it is somewhat difficult to determine any radical deviation in its course. While the elongation-reduction curves certainly show very marked changes in direction, it is difficult to ascertain the points of change with the precision that can be applied to the curves already considered.

One of the most important researches in this connection is that of Alkins.‡ Alkins subjected a bolt of copper, $\frac{3}{16}$ in. in diameter (annealed 4 hours at 600 deg. C.), pickled, to a succession of drafts corresponding to the successive sizes of the Imperial Wire Gauge, from 000000 down to No. 19, *i.e.*, 25 drafts in all. The wires so obtained were tested in tension, and the curve shown in Fig. 2 of his paper was published by Alkins with a view to demonstrate the relation that was found to exist between the cross-sectional areas and the ultimate tensile strengths of the wires that had been tested. The figures published by Alkins have been utilised in the preparation of Fig. 1, which shows the relation existing between ultimate tensile strength and percentage reduction in diameter of wire. This graph has been prepared in order that a clear idea may be gained of the general form that might be expected of tenacity-reduction curves, given that all metals and alloys were subject to the same general laws of deformation as is copper.

It is very clearly demonstrated in Fig. 1 that when a copper bolt, previously annealed at 60 deg. C. and $\frac{3}{16}$ in. in diameter, has been reduced in diameter about 29 per cent., it is so changed in condition that its ultimate strength in tension tends towards a constant value over a narrow range of reduction. Alkins has suggested, tentatively, that this phenomenon may be connected in some way with the transformation to which copper is subject at 70 deg. C. If this suggestion is correct, it is possible that this effect of the 70 deg. C. transformation would be noticeable in alloys of copper that were subjected to reduction. There may, however, be other more acceptable hypotheses as to the nature of the change in copper. In the latter part of this paper the author will endeavour to support such an hypothesis, by recording the results of other experiments that have been conducted, with the view of elucidating the effect of cold work on the mechanical properties of the 39 per cent. zinc-copper alloy.

3. *Further Research into the Effect of Deformation on the Mechanical Properties of the Metals and Alloys.*—In order to determine the effect of reduction by rolling on an alpha-beta brass, a casting of 61 : 39 brass, containing only traces of impurities and 1·6 in. in thickness, was, without prior treatment, subjected to deformation in the rolls. Tensile hardness and micrographic tests

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* Paper read before the Institute of Metals on Wednesday, March 26, 1919.

† "*Carnegie Scholarship Memoirs*," 1911, vol. iii, page 320.

* "*Carnegie Scholarship Memoirs*," 1911, vol. iii, page 320.

† Abstract by Descroix, *Revue de Métallurgie*, 1913, No. 10, page 106.

‡ Journal of the Institute of Metals, No. 2, 1918, vol. xx. page 33.

were made on the strips when the complete series of the same was to hand. The results of the tensile tests are tabulated below :—

Thickness of Strip in Inches	Area of Test-piece. Sq. In.	Yield-Point. Tons per Sq. In.	Ultimate Stress. Tons per Sq. In.	Elongation per Cent.	Percentage Reduction in Thickness of Strip.
1·600	¼	7·5 7·5	23·5 23·5	58·0 58·0	nil
1·200	¼	22·0 22·5	30·0 30·2	23·0 23·0	25
1·025	¼	26·0 28·0	34·2 34·0	18·5 16·0	35·9
0·800	¼	33·0 34·0	38·0 37·8	12·0 13·0	50·0
0·700	¼	36·0 35·2	41·2 40·2	12·0 12·5	56·3
0·615	¼	39·2 39·6	43·7 42·8	11·5 5·0	61·6
0·518	¼	44·4 42·8	45·2 45·8	10·0 14·5	67·6
0·400	¼	42·4 46·4	46·9 48·2	14·0 9·0	75·0

As will be seen, two test-pieces were taken from each of the strips. Both samples were cut in such a manner that the longitudinal axis of the test specimen corresponded in direction to the direction of rolling. All the test specimens were of such dimensions that the gauge length = 4 $\sqrt{}$ area of specimen. The test results are therefore comparative, although made on samples differing greatly in cross-sectional area. The yield point was taken to be that load which induced a permanent set of 0·002 in. on a length of 2 in.

The average values for the factors dealt with in the above table have been employed in the preparation of Fig. 2, which shows the yield point, ultimate stress, and percentage elongation-reduction graphs for a 39·00 per cent. zinc-copper alloy.

Much fuller tests were carried out by means of the Brinell test. Five tests samples were cut from each of the strips and the Brinell numbers of the same were determined. Each of the samples was tested in at least two places. In certain cases, three in all (Nos. 51, 54 and 75), as many as five or more points in the samples were tested. The samples referred to specially were characterised by the presence of areas in which impressions 0·10 mm. (approximately) less in diameter were obtained than obtained elsewhere in the strip. All the impressions were made on the rolled skin of the strip samples, and these hard areas may therefore have been caused by the application of excess work on the material, owing to the presence of foreign matter on the strip at these points during the process of rolling. The average Brinell numbers for the seven groups of samples are given below :—

Group number ..	2	3	4	5	6	7	8
Thickness of strip in inches ..	1·200	1·025	0·800	0·700	0·615	0·518	0·400
Percentage reduction	25	35·9	50	56·3	61·6	67·6	75
Sample Number	mm.	mm.	mm.	mm.	mm.	mm.	mm.
1	2·27	2·07	1·99	1·89	1·88	1·85	1·82
2	2·16	2·05	1·96	1·85	1·87	1·85	1·80
3	2·16	2·05	2·00	1·86	1·86	1·86	1·81
4	2·17	2·05	1·94	1·89	1·88	1·85	1·80
5	2·22	2·05	1·96	1·84	1·87	1·86	1·81
Average Brinell numbers	130	150	163	181	181	185	194

The average Brinell numbers given above have been utilised in the preparation of Fig. 3. The Brinell number of the original strip (as cast) was 77.

The micrographic analysis of the samples was conducted on surfaces at right angles to the rolled surfaces of the strips and parallel to the direction of rolling. The photomicrographs, Figs. 4 to 10 (Plate I.), are of samples that had been polish-attacked on parchment, ammonia having been employed as attaching reagent, and freshly ignited magnesia as polishing reagent. The magnification of the photomicrographs is 75 diameters and the illumination is vertical in every case. With the exception of Fig. 6, the direction of rolling corresponds with the direction of the longer sides of the micrographs. In Fig. 6 the direction of rolling is at right angles to the direction of the longer sides of the micrograph. No photomicrograph has been obtained of the unworked alloy.

We are now in a position to consider the investigation detailed above. There appears to be satisfactory evidence of a somewhat similar phenomenon to that recorded by Alkins. The Brinell number-reduction graph (Fig. 3), particularly, shows a very clear inversion in the neighbourhood of 50 per cent. reduction and, while the author is prepared to admit the desirability of closer investigation, he considers the evidence satisfactory, in view of the results of Alkins' tests and of others recorded below. The micrographs are of interest when considered in the light of the graphs given in Figs. 2 and 3. Little evidence as to the effect of work upon the samples that have undergone up to 36 per cent. reduction is afforded. Figs. 4 and 5 might well have been micrographs of cast 39 per cent. brass. In Fig. 6, however, that showing the micrograph of the samples that has undergone 50 per cent. reduction, distinct signs of the effect of work is visible in the structure. The other micrographs leave no doubt as to the condition of the samples they represent.

FIG. 4. PERCENTAGE REDUCTION 25 PER CENT.

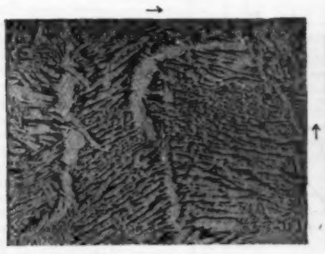


FIG. 5. PERCENTAGE REDUCTION 35.9 PER CENT.

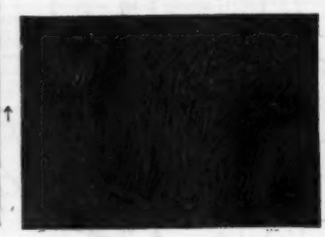


FIG. 6. PERCENTAGE REDUCTION 50 PER CENT.

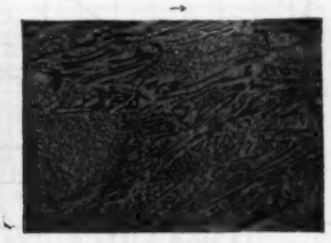


FIG. 7. PERCENTAGE REDUCTION 56.3 PER CENT.

FIG. 8. PERCENTAGE REDUCTION 61.6 PER CENT.

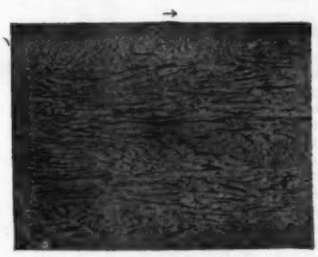


FIG. 9. PERCENTAGE REDUCTION 67.6 PER CENT.

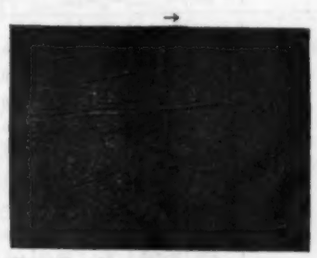


FIG. 10. PERCENTAGE REDUCTION 75 PER CENT.

MAGNIFICATION—75 DIAMS. ILLUMINATION—VERTICAL. REDUCED BY ONE-THIRD. THE ARROWS INDICATE DIRECTION OF ROLLING.

Now, as to an explanation of the phenomena observed. Hanson, at the last meeting of this Institute, suggested the following law of annealing for strained metals and solid solutions :—

"For every degree of deformation there is a critical recrystallisation temperature at which crystal growth is extremely rapid, and the size of the crystals produced by this growth is the greater the smaller the amount of deformation preceding such annealing."

The suggestion is here made that this law may be extended to meet the case of the 39 per cent. brass under consideration, as well as that of the copper investigated by Alkins. This law admits of the possibility of the temperature of the working of the metal or alloy coinciding with the "critical recrystallisation temperature at which crystal growth is extremely rapid." It might even be inferred that the converse of the above law is true—that for every temperature there is a critical degree or range of deformation over which recrystallisation is extremely rapid.

The process of cold work, viewed in the light of Beilby's theory, may be considered to result in the production of amorphous matter at the expense of crystalline matter. This may be the ultimate result, but it is suggested that there is a continuous tendency towards recrystallisation of the amorphous phase at all stages of reduction up to and beyond the critical degree or range of deformation. It seems possible that the reaction

$$\text{Amorphous} \rightleftarrows \text{crystalline} \quad . \quad . \quad (1)$$

not only tends to take place, but actually does occur, to an extent that increases as the deformation to which the material has been subjected increases (i.e., as the proportion of the amorphous phase present in the material increases), suffering a change in its rate when the critical degree or range of deformation or reduction has been attained.

Fig. 11 has been prepared with the view of demonstrating this hypothesis. Certain assumptions have been made. For example, it has been assumed that the metals and alloys as cast are devoid of such amorphous material as is produced as a result of deformation. Further, it has been assumed that, were it not for the phenomenon of recrystallisation here hypothesised, the increase of amorphous material would be directly proportional to the percentage reduction of the material due to work. In Fig. 11 the uniform increase in the proportion of amorphous material that might be expected, were the supposed phenomenon of recrystallisation non-existent, is represented by the straight line AB. The supposed reaction

$$\text{Amorphous} \rightleftarrows \text{crystalline} \quad . \quad . \quad (1)$$

leads to a diminution of the total proportion of the amorphous phase that might be expected, from a consideration of the line AB, to be present in the material, after having been subjected to a given degree of deformation. The proportion of crystalline matter formed as a result of the reaction given in equation 1 is represented by the line ACD, which is shown to suffer a change in direction at C. C represents, then, the commencement of a critical range of deformation within which the rate of recrystallisation increases at first very rapidly, then more slowly, until the range has been passed, when recrystallisation will generally continue at a rate greater than that attained prior to the critical range of deformation.

If the values represented by points on the recrystallisation curve, ACD, be substracted from the values represented by points on the curve AB, the curve AEF, which represents the actual proportion of the amorphous phase present under any degree of deformation, is obtained—a curve which is somewhat similar to those given in Figs. 1 and 3.

4. *Further Evidence of the Presence of an Inversion in the Properties of Metals and Alloys subjected to Progressive Cold Work.*—Mr. A. H. Hall, in the discussion of a paper by Rothera* on the "Application of Electrical Driving to Existing Rolling-mills," showed very clearly that the power absorbed in rolling brass strip was greatly increased when the percentage reduction in thickness of strip has reached a certain very definite value.

An examination of the results of a number of tests similar to those referred to by Mr. A. H. Hall has been made, and the relation between the percentage reduction in thickness of 30 per cent. zinc-copper and 20 per cent. nickel-copper strip, and the power absorbed in rolling the same is shown in Figs. 12 and 13. The detailed information upon which these diagrams have been based is given in the table on page 292.

The method whereby the results recorded above were obtained consisted in the continuous supply of strip to rolls which were electrically driven. As the uniform

* *Journal of the Institute of Mechanical Engineers*, June, 1914, No. 1, page 48.

supply of strip continued, note was taken of the various factors necessary for a determination of the power absorbed in the reduction of the strip. No account was taken in the above calculations of the power actually required to keep the rolls in motion when not employed in the reduction of the strip. As, however, this is a practically constant factor, the ratio Watts/reduction given above is relatively the same for all degrees of reduction. Actually the ratio would be somewhat less in value.

There can be little doubt as to the existence of inversions in the curves shown in Figs. 12 and 13. In the case of the 30 per cent. brasses the critical range of deformation is in the neighbourhood of 35 per cent. to 45 per cent. reduction for strip initially 1·60 in. thick and of 37·5 per cent. to 47·5 per cent. reduction for strip initially 1·65 in. thick; in the case of the 20 per cent. nickel-copper alloy this range is in the neighbourhood of 47·5 per cent. to 62·5 per cent. (?) reduction for strip initially 1·45 in. thick.

Upon the results obtained in the case of the 30 per cent. brass may be based, tentatively, another hypothesis as to the nature of the critical range of deformation. It is suggested that some evidence is given in favour of the view that the less the initial thickness of the material undergoing deformation—other things, of course, being equal—the lower the point at which the critical range of deformation commences. This suggestion receives further support from the results of Alkins' tests. Further evidence is afforded of the correctness of this view by practical experience. It is very generally known that the less the initial thickness of material undergoing deformation, the less the amount of deformation to which it may, without ill effect, be subjected. It still remains for a determination of the law connecting the critical degree of deformation and the initial thickness of strip to be made by such as are sufficiently interested in this subject to pursue the same further.

In concluding this paper the author desires to express his indebtedness to the many friends who have assisted him in his work by their kindly criticism and advice, and his thanks to the Chief Superintendent of the Ordnance Factories, Woolwich, for permission to publish certain of the data upon which his hypothesis as to the existence of a critical range of deformation has been founded.

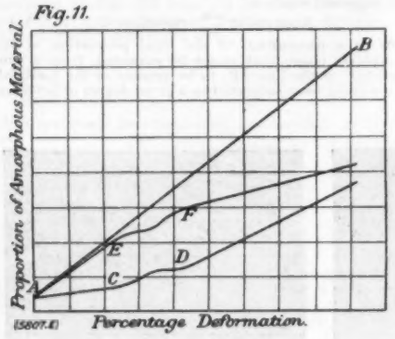
Summary.—1. The facts generally accepted as to the effect of work on the general properties of the metals and alloys have been summarised.

2. The results of the work of certain investigators into the effect of cold work on the mechanical properties of the metals and alloys have been collated, and evidences have been noted of the existence of points of inversion in the graphs connecting the percentage reduction by work and the mechanical properties of certain metals and alloys, *e.g.*, steel, brass, copper, &c.

3. The results of further investigations have been presented, and an explanation of the observed phenomena has been tentatively put forward. The hypothesis that for every temperature there exists a critical range of deformation at which recrystallisation of the amorphous material accruing as a result of cold work is extremely rapid has been discussed.

4. Still further evidence in favour of the above hypothesis, based upon the relation found to exist between percentage reduction in the thickness of rolled strip and the power absorbed in the reduction of the strip, is described, and an extension of the hypothesis is suggested—that the critical degree of deformation commences at a lower stage of reduction the less is the initial thickness of the material undergoing deformation.

Fig. 11.



Material	Thickness in Inches.	Reduction in Inches.	Reduction p.c. Original Thickness.	Reduction. Total per cent.	Watts.	Watts / Reduction.
30 per cent zinc-copper	1·600					
		0·270	16·9	16·9	98,000	5,800
	1·330					
		0·120	7·5	24·4	99,000	13,200
	1·210					
		0·090	5·6	30·0	130,950	23,380
	1·120					
		0·080	5·0	35·0	156,800	31,360
	1·040					
		0·070	4·4	39·4	147,000	33,410
	0·970					
		0·070	4·4	43·8	155,200	35,270
	0·900					
		0·060	3·8	47·6	158,400	41,680
	0·840					
		0·045	2·8	50·4	164,010	58,570
	0·795					
		0·040	2·5	52·9	144,420	57,760
	0·755					
		0·030	1·9	54·8	143,650	75,600
	0·725					
		0·025	1·6	56·4	101,000	63,120
	0·700					
30 per cent zinc-copper	1·650					
		0·350	21·2	21·2	115,000	5,420
	1·300					
		0·150	9·1	30·3	120,000	13,180
	1·150					
		0·120	7·3	37·6	145,500	19,930
	1·030					
		0·100	6·1	43·7	142,300	20,680
	0·930					
		0·080	4·8	48·5	99,000	20,620
	0·850					
		0·050	3·0	51·5	114,000	38,000
	0·800					
20 per cent nickel-copper	1·45					
		0·25	17·2	17·2	150,200	9,240
	1·20					
		0·17	11·7	28·9	161,300	13,790
	1·03					
		0·14	9·7	38·6	169,800	17,500
	0·89					
		0·13	9·0	47·6	182,000	20,220
	0·76					
		0·12	8·3	55·9	171,500	20,660
	0·64					
		0·11	7·6	63·5	166,700	21,930
	0·53					
		0·10	6·9	70·5	165,300	23,960
	0·43					
		0·07	4·8	75·2	116,400	25,250
	0·36					

Fig. 12. CAST 70: 30 BRASS.

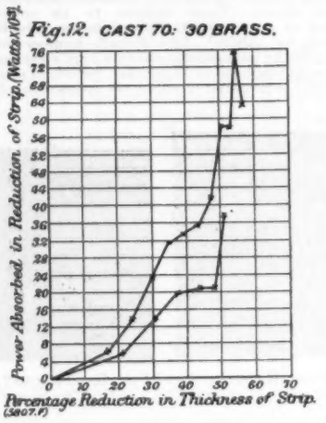
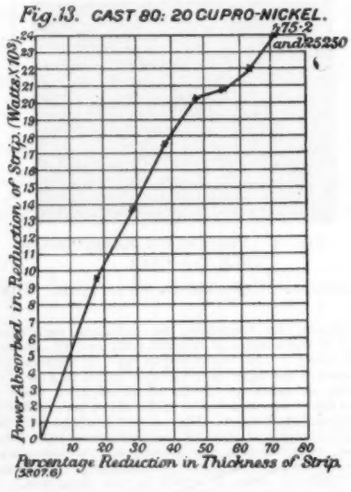


Fig. 13. CAST 80: 20 CUPRO-NICKEL.



Mercury Production in the United States.—According to statistics compiled by F. L. Ransome, of the United States Geological Survey, the mercury production of the United States during the first quarter of 1919 very distinctly showed the lessened demand for mercury with the end of the war, both in the production figures and in the prices. The total production amounted to 5,960 flasks, against 8,674 flasks in the same period of 1918. The prices had steadily been sinking, from 103·75 dols. in January to 90 dols. and 72·80 dols. in February and March, but were still higher than in pre-war times, though not high considering the general rise of prices.

CATALOGUES.

Tubes and Bars.—The Talbot Stead Tube Company, Limited, Birchills, Walsall, send a catalogue showing steel tubes and bars, both cold drawn and hot rolled. The tubes include qualities for naval and locomotive boilers, superheaters, and hydraulic pipes. Bright-finished steel bolts and nuts are also made.

Primary Cells.—Three standard sizes of cells, of one, two and three pints capacity, are shown in a priced catalogue, issued by the General Electric Company, Limited, of Witton, Birmingham. Considerable economy is claimed for these cells in comparison with porous pots, the former giving about three times the ampere hours.

Electric Welding.—Two publications dealing with the uses of welding on tramway and light railway systems come from Alloy Welding Processes, Limited, 149 Leadenhall-street, E.C. 3. One describes the welding plant required, and the other the various repair jobs that usually arise, and how they may be carried through.

Furnaces.—A hand-fired furnace suitable for burning coke breeze, fine coal, and large and small refuse fuels of poor quality in gas works and collieries, is shown in a catalogue from Messrs. Ed. Bennis and Co., Limited, Little Hulton, Bolton. The bars are narrowly spaced and rest on troughs from which the ashes are automatically removed.

Fans.—A most instructive pamphlet on fans, by Mr. James Keith, comes from the James Keith and Blackman Company, Limited, Farringdon-street, E.C. It contains some 50 illustrations of various fans with particulars of construction and fitting up, and some interesting references to the uses of various types. There is an historical introduction, lucid, but, if anything, too brief.

War Record.—One of the simplest and most effective of the engineering works war records is issued by Messrs. Davidson and Co., Limited, Belfast. Out of 700 employees 194 joined the colours: viz., 2 directors, 9 office staff, 6 works staff, and 176 workmen. Of these 19 perished, including Captain J. S. Davidson, who was killed in action at Thiepval, France, on July 1, 1916, when the Ulster Division was attacking. The output of fans for war service is interesting, not only for its volume, but as illustrating the great variety of uses for these appliances.

Stoking Machine.—The Erith-Riley stoking machine, for water-tube boilers, is fully explained by the makers, Erith's Engineering Company, Limited, 70 Gracechurch-street, E.C., in a special catalogue. It is an underfeed stoker capable of automatically and continuously feeding, cleaning and discharging ash. The design allows the use of slow-moving mechanism placed so that it is not exposed to the fiercest heat. The gases from the green coal pass through a hot zone, in which they are consumed, so that very little smoke is discharged. The essential parts are shown, and also fully fitted-up installations.

Steel.—Another record of war work is contained in a pamphlet issued by Messrs. Edgar Allen and Co., Limited, Sheffield, makers of tool and special alloy steels. The company delivered over 1,000,000 manganese steel helmets—now often called by the quite inappropriate name "tin hats"—as well as all kinds of parts for land, sea and air craft requiring material of exceptional qualities. The company also produced a bullet shield on wheels, which was used in war before the "tanks," and it is curious to read that the experimental work in this direction was initiated by private subscription and carried through by a private firm.

Motor Lorries.—The lorry, and other vehicles, used for such work as delivering goods in large towns, spend so large a proportion of their time at rest that the engines, whether steam or petrol, do not prove a great economy as compared with the horse. Electric power would evidently be suitable for these vehicles if storage batteries were a little nearer to perfection. The Orwell electric lorries, made by Messrs. Ransomes, Sims and Jefferies, Limited, Ipswich, are described in a catalogue received from the selling agents, Messrs. Mossay and Co., Limited, 7, Princes-street, S.W. 1. This catalogue is worth careful attention.

Electric Cranes.—The "electric block" made by the Vaughan Crane Company, Limited, Openshaw, Manchester, is really a complete hoisting machine, made in standard sizes and easily adapted to be used on a fixed hook, or to travel on a girder by hand or power, with the addition of a trolley. The motor is controlled by a rope pulled from the floor level, or, in the larger sizes, a cage is added in which the driver sits and travels with the crane. It is made in sizes to lift from ½ ton to 4½ tons, and adaptations are shown to jib-wall cranes, goods hoists, and girder travelling cranes. It is an excellent example of an engineering product worked out on standard manufacturing principles.

War Aircraft.—The record of the aircraft department of Messrs. William Beardmore and Co., Limited, Dalmuir, must rank amongst the first of its kind. Both quantity and variety of type are really wonderful. The illustrations include airships, airplanes, seaplanes, engines, and a ship, H.M.S. Argus, built by the firm as a seaplane carrier. The firm, who had made a beginning in this work before the war, expanded their plant with great rapidity as soon as the need arose. There is not much text in the record, and no attempt to state the totals of production. Some fine workshop pictures indicate the enormous scale on which production was carried on, and also show the rolling of great armour plates and a series of nearly completed naval guns from 4-in. up to 15-in. bore.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

AERONAUTICS.

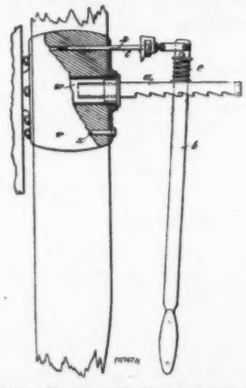
4743/15. H. Leitner, Westminster, London. Screw Propellers. (8 *Figs.*) March 26, 1915.—This invention relates to screw propellers designed for use on aircraft, and to that class of propeller in which the blades are hollow, and are composed of separate sheet metal plates joined together at the edges. According to this invention, two or more blades of a propeller are formed together, by rolling, stamping, or otherwise shaping to the required thickness and form a pair of sheet metal plates, each plate forming the front surface of one blade and the rear surface of an adjacent blade. The drawing shows a two-bladed

Fig. 1.

Fig. 2.

propeller; the blades are formed from two sheet metal plates, one of which plates forms the surface *a* of the two blades, and the other the surface *b* thereof, so that when the shaped plates are placed together two complete blades are formed. *c* is the hub, which is of a tubular or spool shape, and this hub is enclosed by the two blades *a* and *b*, which are secured to it by welding, autogenous soldering, or other suitable means. The blades may be strengthened internally by suitable means. *d* represents pieces of thin metal with which the spaces left at the hub between the plates *a* and *b* constituting the blades, are filled in. (*Accepted June* 18, 1919.)

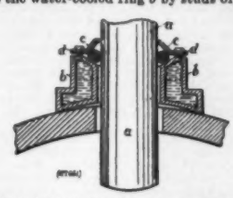
127,673. The Sopwith Aviation Company, Limited, Kingston-on-Thames, and H. E. Cato, Norbiton. Aircraft. (3 *Figs.*) May 23, 1917.—This invention relates to an improved tool for extracting the fixing bolts of the propellers of aeroplanes. The improved tool consists essentially of a fulcrum post having a base adapted to engage the end of the shaft on which the propeller is mounted and a series of longitudinally-arranged transverse abutments, a lever having a transverse abutment adapted to co-operate with the abutments on the fulcrum post to form a fulcrum between said parts, and a forked piece coupled to the lever and adapted to engage the heads of the bolts. The fulcrum post *a* has a series of longitudinally-arranged ratchet teeth forming transverse abutments thereon, and the lever *b* has a transverse pin also forming a transverse abutment. The forked piece *c*, adapted to engage the heads of the bolts *x*, is coupled to the lever *b* by means of a link. The fulcrum post *a* is preferably fork shaped, so as to allow the lever *b* to pass through



it. The ratchet teeth are preferably shaped to form bearings to enable the pin carried by the lever *b* to turn or rock in them after engagement. The engaging abutments form a fulcrum which enables pressure applied to the free end of the lever in a direction towards the propeller to move the other end of the lever away from the propeller and therefore in the direction to withdraw the bolts from the boss *v* of the propeller, the longitudinally-arranged series of ratchet teeth enabling the fulcrum of the operating lever to be successively advanced as the bolt is being withdrawn. To keep the fulcrum pin in engagement with the ratchet teeth, a spring *s* is mounted on the upper end of the lever *b* and is arranged to operate to press said lever upwards relatively to the fulcrum post *a*. The base of the fulcrum post *a* has a flange which carries a stud, which is adapted to fit in the front end of the hollow propeller shaft *w*, and so form a support for the tool and enable it to be rotated to bring it into position to withdraw the several circumferentially-arranged bolts *x*. (*Accepted June* 18, 1919.)

ELECTRICAL APPARATUS.

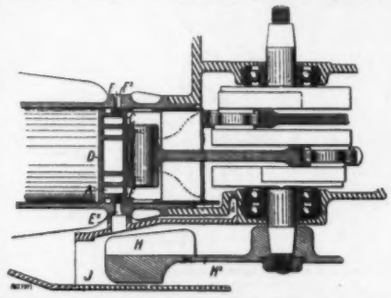
127,661. T. H. Watson and Co. (of Sheffield), Limited, Neepsend, Sheffield, H. A. Greaves, Nether Edge, Sheffield, and H. Etchells, Sheffield. Electric Furnaces. (2 *Figs.*) May 16, 1917.—The invention relates to the sealing of the openings in the roof and walls of an electric furnace through which the electrodes are introduced. According to this invention, there is placed on each electrode at the point where it enters an electric furnace, an encircling water-cooled metal ring *b* having its inner top edge bevelled to admit of a ring of fireproof packing *c* lying in the annular groove so formed between the water-cooled ring *b* and the electrodes *a*. This packing ring *c* may be made of asbestos and graphite. A washer *d* is also placed over the electrode *a* and has its inner periphery bevelled upwardly and adapted to lie on the top of the packing ring *c*. This washer *d* is secured to the water-cooled ring *b* by studs or bolts, and when



so fixed tends to hold the packing ring *c* closely against the face of the electrode *a*. The water-cooled ring *b* may be L-shaped in section and of a suitable depth to chill any gases circulating between it and the electrode, and also to keep the packing *c* cool, which result is obtained without making a bulky cooler. The outer lower rim of water-cooled ring rests upon, and is cemented to, the brickwork or casing of the furnace. (*Accepted June* 18, 1919.)

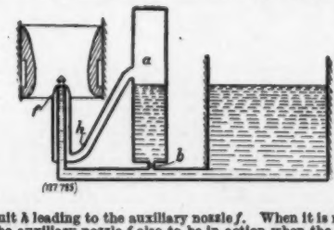
GAS ENGINES, PRODUCERS, HOLDERS, &c.

127,757. Douglas Motors, Limited, Bristol, S. L. Bailey, Bristol, and W. W. Douglas, Bristol. Internal-Combustion Engines. (1 *Fig.*) July 13, 1918.—This invention relates to cooling devices for the pistons of internal-combustion engines, and has reference to the type of cooling device wherein the piston is provided with a chamber through which cooling air passes, and whereof one wall forms the head or crown of the piston. According to this invention, a cooling device of the type described comprises the combination with inlet and outlet apertures for the chamber which are pierced in the sides of the piston, and ports formed in the wall of the cylinder to register with each of the said apertures when the piston is at one end of its stroke, of an air supply device comprising a fan on the engine crankshaft which delivers into one of the said ports so as to send a blast of air through the chamber and along the underside of the crown when the ports and apertures register. The



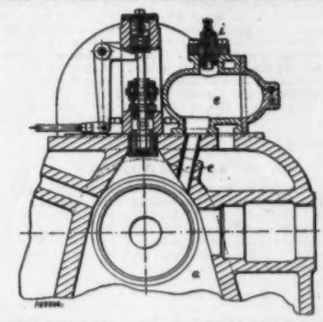
chamber A is formed in the upper part of the piston by the provision therein of a transverse wall C under the piston head D. Two apertures constituting respectively an inlet E and an exit F for the air are formed opposite one another in the sides of the piston to communicate with the interior of the chamber A, and are situated below and clear of the piston-ring. A pair of ports E^2 and F^2, corresponding with the apertures E and F, are pierced in the wall of the cylinder and simultaneously register with the corresponding respective apertures E and F in the chamber when the piston is at the outer end of its stroke as shown. The port E^2 communicates with the delivery outlet of a fan H. The fan may be attached to or form part of the flywheel H^2, which is provided with a fan casing J. By this means a blast of air is delivered by the fan through the chamber A, each time the piston arrives at the end of its out stroke, thus cooling the walls and piston crown, driving out the heated air and replacing it by cool air. (*Accepted June* 18, 1919.)

127,755. J. Fagard, London. Carburettors. (3 *Figs.*) July 6, 1918.—This invention relates to carburettors of that type having an auxiliary nozzle situated in the choke tube and communicating with a fuel well open to the atmosphere only through a restricted aperture. According to the invention, fuel is admitted to the well *a* through an inlet *b* in the lower portion, and the auxiliary nozzle *f* communicates with the well at a point which is above the level of the fuel therein at medium speeds, so that at high speeds the increased depression created in the well causes the fuel to rise therein until it reaches the



conduit A leading to the auxiliary nozzle *f*. When it is required for the auxiliary nozzle *f* also to be in action when the throttle is being opened so as to assist the pick-up or acceleration, the nozzle communicates with the well by means of a conduit which opens into the latter at a point below the normal level of the fuel in the reservoir, and means are provided whereby the level of the fuel in the well falls below said auxiliary nozzle conduit at medium speeds, thus putting the said nozzle out of action, but again rises at increased speeds so as to bring the nozzle into operation. (*Accepted June* 18, 1919.)

127,698. G. M. Blackstone, Stamford, F. Carter, Stamford, and E. Carter, Stamford. Internal-Combustion Engines. (3 *Figs.*) November 8, 1918.—The invention relates to engines of the kind in which heavy fuel is injected into the combustion chamber at or near the end of the compression stroke by means of compressed air. According to this invention, during the suction stroke, light fuel, with a small proportion of air, is drawn from a receptacle and led past a valve into an auxiliary combustion chamber *c* connected with the main combustion chamber *a*. The auxiliary chamber *c* is provided with an electric firing device *i*, by means of which the light fuel charge is fired at, or near, the end of the compression stroke, and the resultant flame issues into the combustion chamber *a* and fires the heavy fuel



charge, which is injected into the combustion chamber *a* by means of compressed air in the usual well-known manner. The auxiliary chamber *c* may be a recess in the combustion chamber, or may be connected with the same by means of a port *ci*. The quantity of air drawn into the auxiliary chamber being only sufficient to allow the fuel to be sucked in, the remaining air required for combustion is compressed into the auxiliary chamber from the main combustion chamber. (*Accepted June* 18, 1919.)

127,672. L. Coatalen, Wolverhampton, and The Sunbeam Motor Car Company, Limited, Wolverhampton. Internal-Combustion Engines. (4 *Figs.*) May 21, 1917.—The invention comprises the disposition of the valves obliquely around the axis of the engine cylinder so that the valve axes have a common intersection on the cylinder axis, which intersection is at the centre of curvature of the cylinder head, and the transmission of motion to the valves through tappets from rocking levers actuated by cams on a shaft mounted at right angles to the cylinder, the tappets or their bearings taking the lateral stresses due to small

Fig. 1.

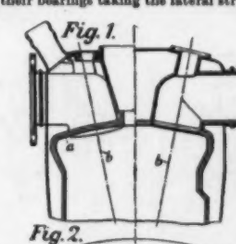
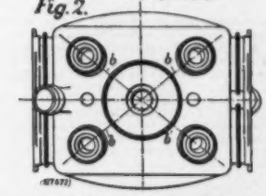


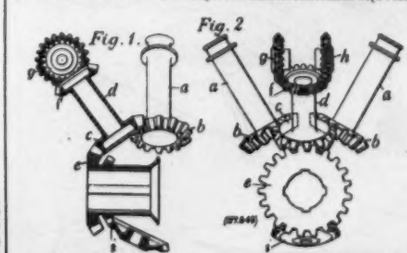
Fig. 2.



sliding movements which occur between the tappets and the rocking levers. Two inlet and two outlet valves are arranged in each cylinder head. These are situated around and with their axes inclined to the cylinder axis. The valve axes meet at a point on the cylinder axis and this point is the centre of curvature of the cylinder head *a*. All the valve axes *b* are therefore normal to the internal surface of the cylinder head. The valve seatings *c* are formed by apertures in the cylinder head. By this arrangement simple operations are employed in the machining of the cylinder head both outside and inside. (*Accepted June* 18, 1919.)

127,649. L. Coatalen, Wolverhampton, H. C. M. Stevens, Wolverhampton, and The Sunbeam Motor Car Company, Limited, Wolverhampton. Internal-Combustion Engines. (2 *Figs.*) May 11, 1917.—This invention relates to internal combustion engines of the V type. When the camshafts are arranged over the cylinders or in any other position with their axes parallel to the crankshaft, the camshafts are ordinarily driven from the crankshaft through countershafts when trains of wheels are not used. The object of this invention is to overcome

Fig. 1. *Fig. 2*

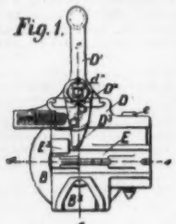


the difficulty which has hitherto been experienced in obtaining a satisfactory drive of the countershafts, particularly when the angle between the cylinders or the countershafts is in the neighbourhood of 60 deg. or less. The present invention comprises the transmission of the required motion to the shafts by gearing one of the shafts by a bevel wheel to a bevel wheel on the crankshaft which drives a wheel on an intermediate shaft, and motion is taken from the latter through other wheels to the countershafts, or a single wheel on the crankshaft drives a wheel on one of the countershafts, and another wheel on the latter drives a whee

on the second countershaft through a wheel on the intermediate shaft. In carrying the invention into effect, a pair of relatively inclined countershafts *a* are used. A bevel wheel *b* on each shaft gears with a bevel wheel *c* on an intermediate shaft *d*. The wheel *c* gears with another bevel wheel *e* on the crankshaft. The axes of the countershafts lie in the same vertical plane, but preferably the axis of the intermediate shaft *d* is inclined thereto. From the intermediate shaft motion can be taken through wheels *f*, *g* and *h* to the magneto spindle, air starting distributor or other accessories. A bevel wheel *i* for driving an oil pump may be arranged to gear directly with the crankshaft wheel *e*. Alternatively the wheel on the crankshaft drives a wheel on one of the countershafts, and another wheel on the same countershaft drives a wheel on the other countershaft through a wheel on the intermediate shaft. This arrangement is practically the same as that illustrated, the difference being that the crankshaft directly operates one of the countershafts, and for convenience of arrangement another wheel is provided on that countershaft for engagement by the wheel on the intermediate shaft. (*Accepted June* 18, 1919.)]

GUNS AND EXPLOSIVES.

127,612. Sir A. T. Dawson, Westminster, London, and Sir G. T. Buckham, Westminster, London. Lock Mechanism. (4 *Figs.*) April 28, 1917.—This invention relates to ordnance lock mechanism of the kind having a sliding lock frame movable transversely to the axis of the gun in a box slide attached to the rear end of the axial vent bolt. According to the invention, the slides on which the lock frame moves are formed partly on the box slide and partly on the axial vent bolt so that the lock frame, when assembled, serves to retain the box slide in its correct position on the axial vent bolt. B is the box slide and C is the axial vent bolt to which the box slide is connected by a continuous screw thread or by interrupted collars in the usual manner. D is the lock frame, D^1 is a lock frame operating handle pivoted at *d x* to a bracket D *x* attached to the lock frame,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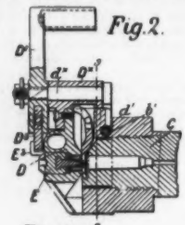


Fig. 2.

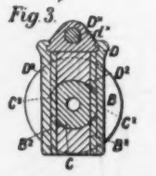


Fig. 3.

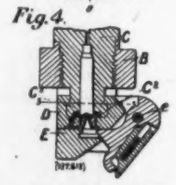
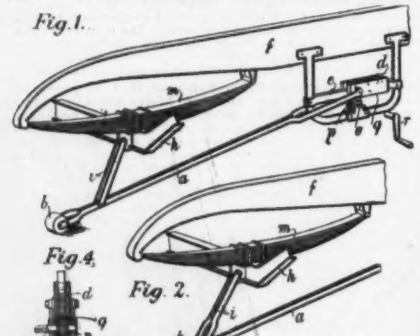


Fig. 4.

and D^1 is a hook-shaped projection on the handle D^1 for engaging in a recess b^1 in the box slide to hold the lock frame in the closed position. E is the firing hammer pivoted at *e* to the lock frame so as to move in a plane transverse to the path of travel of the lock frame and E^3 is a projection on the hammer E with which an extension D^3 of the handle D^1 engages to retract the hammer when the handle is rocked about its pivot to disengage the projection d^1 from its recess b^1 prior to moving the lock frame upwards to the open position. The lock frame D is formed with longitudinal grooves D^2, D^2, adapted to engage with fins B^2, B^2, on the box slide B, and also with fins C^2, C^2, on the axial vent bolt, the latter fins forming continuations of the fins B^2, B^2. In this manner the lock frame serves as aforesaid to retain the box slide in its correct position on the axial vent bolt. (*Accepted June* 18, 1919.)

LIFTING AND HAULING APPLIANCES.

127,074. F. L. Rapson, Liverpool. Lifting Jacks. (3 *Figs.*) April 19, 1918.—This invention relates to lifting jacks having a lever pivoted to a convenient part of the chassis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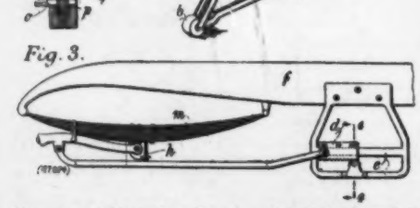
Fig. 2.

Fig. 4.

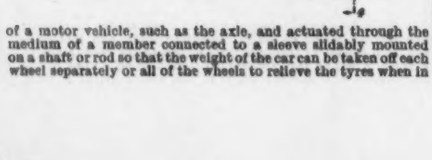
Fig. 3.

of a motor vehicle, such as the axle, and actuated through the medium of a member connected to a sleeve slidably mounted on a shaft or rod so that the weight of the car can be taken off each wheel separately or all of the wheels to relieve the tyres when in the garage, or to jack up the car when it is desired to repair punctures or effect repairs, or to raise the car for washing or inspection purposes. This invention consists chiefly in actuating a lever, pivoted to the axle by a tie or coupling or other members connected to a sleeve or sleeves adapted to be moved along a rod or bar, through the medium of a rack-and-pinion device by the rotation of a hand wheel or handle. A lever *a* having a roller *b* mounted at its lower end, is pivoted adjacent to each wheel of a motor vehicle. Each lever *a* is pivotally connected to a sleeve *d* which slides on a bar *e* secured at each end to the chassis *f*. A link *i* is pivotally connected to each lever *a* and to a bracket disposed in front of the axle *h*. Adjacent to each sleeve *d* is a shaft *o*, on which is mounted a pinion wheel *p*, which engages a rack *q* on the sleeve *d*. This shaft *o* is rotatably mounted and is provided at its outer end with a hand wheel *r*. In operation, the driver places the handle *r* on the shaft *o* adjacent to the wheel having the punctured tyre, and turns the same. This movement rotates the shaft *o* and pinion *p*. The sleeve *d* is moved along the bar *e* and pulls the upper end of the lever *a*, and turns the link *i* to a more vertical position so that the roller *b* contacts with the ground and raises the wheel therefrom. When the tyre is repaired the handle *r* is rotated in the opposite direction to move the sleeve outwardly and raise the jack lever *a* back to its normal position, where it will be screened from view under the spring *m* of the vehicle. (*Sealed.*)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

127,617. J. H. Jones, Newport, Mon. Grinding Machines. (2 *Figs.*) April 30, 1917.—This invention relates to grinding machines of the type in which provision is made for dressing the grinding wheel without removing it from its mounting on the machine. According to the present invention, a machine of the type defined is characterised by the dressing tool being carried upon a hand lever that is so pivotally supported or hinged on the machine that the dresser is guided in a plane path and can be yieldingly moved therein by hand entirely across the working face of the grinding wheel. The machine is constructed with a traversing mandrel, which is entirely enclosed and whose nose is just visible in Fig. 1 at A. The machine is provided with a saddle B and slide rest C that are stationary during the taking of a cut, but are movable to set the tool to the required cut or position. The tool, shown in the drawing, is a V-edge grinding wheel D mounted in a bearing carried upon the slide rest and provided with a driving pulley D^1. Mounted on the bed A^2 is a vertical frame G carrying a pivoted sector plate H whose plane is vertical and parallel to the line of centres of the machine. At the pivotal centre of the plate is a bracket J mounted to revolve with the plate H about a horizontal axis at right angles to the plane of the plate and supporting a lever K that is pivoted to

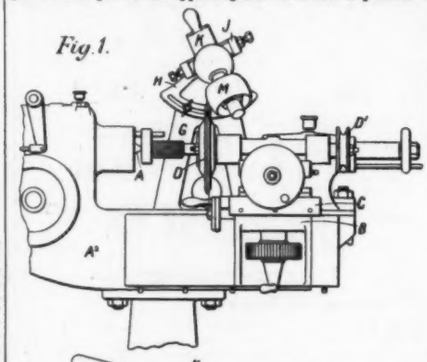
Fig. 1.

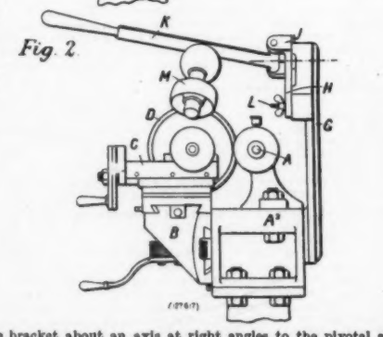
Fig. 2.

the bracket about an axis at right angles to the pivotal axis of the plate and bracket. On the free end of the arm K is mounted a Metcalfe dresser M. The rotation of the bracket about its axis is limited by a screwed pin and nut L, upon the frame G, so that the bracket may be rotated into either of two definite predetermined positions by which the plane of movement of the arm K about its axis is selectively determined. When the grinding wheel has become worn, the bracket J is slewed about its axis into one of the two limiting positions, which two positions have been so predetermined as to bring the axis of the arm into a position at right angles to a plane which is, or is parallel to, the required plane of the face of the wheel to be dressed. The arm is then swung down, the wheel being rapidly driven meanwhile, and the dresser caused to pass across the face to be dressed, any requisite adjustment of the position of the wheel being effected by means of the saddle and slide rest. When this face has been trued, the axis of the arm is slewed by means of the bracket into its other limiting position, and the process repeated on the other working face of the wheel edge. During this process the slide ways of the machine on which accuracy of work depends are not exposed to the grit caused by the dressing. (*Accepted June* 18, 1919.)

127,697. N. Collins, Hendon, London, and P. J. Hays, London. Pulley Clutch Mechanism. (4 *Figs.*) May 6, 1918.—This invention relates to fast-and-loose pulley clutch mechanism, in which a coiled spring is employed to clutch together driving and driven elements and rotate therewith, and wherein uncoiling of the spring causes these elements to be disengaged. The invention consists briefly in means for arresting the revolution of the spring which comprises a disc loosely mounted on a driving sleeve adapted to retain or receive the end of the spring, a detent thereon and a striking gear embracing a pawl to engage the detent and arrest the motion of the disc, and thereby unlock or declutch the parts. A bracket 1 carries a shaft 3. Loosely mounted on the shaft are collars adapted to act as distance pieces in preserving contiguity of the driving and driven members. The driven member consists of a pulley 6, having a sleeve extension 6a, and the driving member is a pulley 7, loose upon shaft 3, and having a sleeve extension 7a. A disc 8 is loosely mounted upon the sleeve 7a, and carries a detent 8a. Disposed over the sleeves 6a, 7a, is a helical spring 9, one end of which is anchored within the disc 8, whilst the other end is free. A pawl 10 on a spindle 11, mounted on the bracket 1, is adapted to engage the detent 8a when the spindle 11 is rocked by the

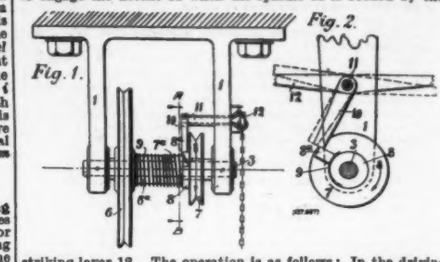
Fig. 1.

Fig. 2.

striking lever 12. The operation is as follows: In the driving position, the pawl 10 is not in engagement with the detent 8a, as shown in dotted lines in Fig. 2, whilst the direction of drive of the pulley 7 is as shown by the arrows marked in Figs. 1 and 2. The motion of the pulley 7 and sleeve 7a causes the spring to bind and grip the sleeves 6a and 7a, thereby transmitting the motion of sleeve 7a to sleeve 6a and pulley 6. In order to declutch, the lever 12 is rocked, whereby the pawl 10 is brought into engagement with the detent 8a to which it acts as a stop. In this manner the end of the spring 9 is held against rotation and consequently expands, thus releasing sleeve 7a, and thereby breaking the driving connection between the two sleeves. (*Accepted June* 18, 1919.)

MINING, METALLURGY, AND METAL WORKING.

127,696. A. P. Smith, Coventry. Casting and Moulding Cores. (8 *Figs.*) May 6, 1918.—This invention relates to an improved core-making machine for casting and moulding operations, and more particularly to the pillar type of such machines wherein the upper core-box is carried by a balanced hand-operated ram mounted to slide vertically in a bracket or head adjustably arranged on the pillar of the machine. *a* is the base of a hand press with a standard *b* having bearings for a shaft *d* on which a counterweighted hand lever *e* is keyed. On the shaft is keyed an arm *f* connected by a link *g* with a plunger *h* mounted on a slide on the standard *b*. *j* and *k* are core-boxes, and to the upper one is secured a stem *m* for securing in the plunger *h* of the

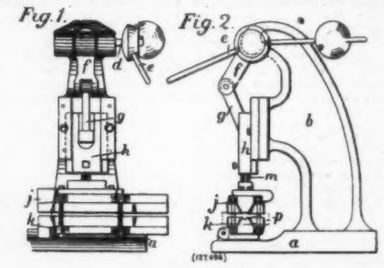
Fig. 1.

Fig. 2.

press. The characteristic feature of the core-boxes is the provision of knife-edges surrounding the "shape" for the cores. To ensure the boxes being set correctly in the press they are provided with lugs having holes to receive guide pins mounted in the lugs of the upper box. In use a surrounding frame comprising for example a band of metal following the "shape" of the boxes is arranged around the bottom box, as indicated at *p* by dotted lines, so that the sand heaped upon the bottom box may be retained by the frame. The plunger with the top box is brought down by the lever *e*, compressing the sand within the "shape" of the two boxes. The knife-edges of the boxes trim away the surplus sand and a well-formed and compressed core is the result. (*Accepted June* 18, 1919.)

MISCELLANEOUS.

127,115. W. Reid, Hartwood. Bricks. (5 *Figs.*) May 31, 1918.—This invention has reference to bricks for the construction of chimney and air vents, flues and the like. The improvements consist in forming the bricks during the operation of manufacture with an angled part or surface having a triangular-shaped part removed. The bricks *a*, which are to form an angled or inclined vent, are formed during the operation of manufacture or moulding with an angled part *b*, by having a triangular-shaped part

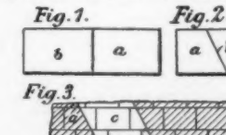
Fig. 1.

Fig. 2.

Fig. 3.

removed. In building an angled vent the bricks *a* are built one over the other so that the angled surfaces *b* lie in a straight line and form the inclined sides of the vent. The front and back of the vent are formed by ordinary rectangular bricks. The width of the vent is obtained by interposing ordinary rectangular bricks *c*. A vent which for a portion is vertical and for another portion is inclined is built by forming the vertical portion as usual and then by forming the inclined portion by means of these angled bricks. (*Sealed.*)